FEASIBILITY, SUITABILITY &
VALUE ANALYSIS REVIEW

Of

OLD FAITHFUL WASTEWATER TREATMENT ALTERNATIVES

For

NATIONAL PARK SERVICE

Department of the Interior

YELLOWSTONE NATIONAL PARK

Rothberg
Tamburini
Winsor

August 3, 1998

Professional Engineers and Consultants

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Executive Summary

Purpose

This report summarizes the value analysis conducted for the Old Faithful Wastewater Treatment Alternatives. The draft alternative report was completed in December, 1997. The final alternative report was presented to project members from Yellowstone National Park and Denver Service Center in a three-day workshop held during the last week of June, 1998. The A/E presented design goals, flow projection methodology, treatment alternatives, and project schedule. Each topic was reviewed, and value engineering changes were incorporated where appropriate. The selected alternative will be taken into schematic design.

Project Background

The existing wastewater treatment plant (WWTP) at Old Faithful discharges ammonia from the evaporation/percolation ponds, resulting in elevated concentrations of nitrate and chloride in the groundwater aquifer. The aquifer is a Class I Groundwater of the State, suitable for domestic use. As such, discharges into the groundwater are not allowed if they result in raising contaminant concentrations in excess of any of the standards for Class I Groundwater. The mechanical plant typically meets secondary effluent discharge limits of 30 mg/L BOD and 30 mg/L TSS. However, groundwater monitoring at the WWTP shows that chloride concentrations are ±30 mg/L (limit 250 mg/L) and nitrate concentrations are approaching the 10 mg/L limit.

Future flow and loading estimates were developed from review of operating data and information obtained from transportation reports prepared for Yellowstone National Park. A twenty-year design life was used in the estimates. The projected visitor season (summer) maximum flow was 0.464 MGD. Projected shoulder season (winter) maximum flow was 0.068 MGD. These flows are less than the current permitted flow of 0.51 MGD. Therefore, the new facility will retain the current permitted capacity.

The current operational approach is to operate the mechanical facility during the visitor season and operate septic tanks during the off-season. The mechanical plant

nitrifies during a portion of the visitor season after the plant's biomass has been established. During most of the year, the effluent contains significant concentrations of ammonia. As the effluent percs into the groundwater, the soil converts the ammonia to nitrate. Groundwater nitrate concentrations surrounding the Old Faithful plant are reaching the limit of 10 mg/L. Modifications to the facility would include abandoning the septic tanks and operating the mechanical facility year round in a nitrifying/denitrifying mode. Denitrification would remove the nitrate from the effluent, thus decreasing the nitrate concentration in the surrounding aquifer.

Wastewater Treatment Facility Alternatives

A minimum of three wastewater treatment alternatives with proven track records to meet Wyoming Department of Environmental Quality (DEQ) requirements of 30 mg/L BOD, 30 mg/L TSS, and 10 mg/L nitrate were analyzed: expansion of existing facility, rotating biological contactor (RBC) facility on the bench adjacent to the existing percolation ponds, and a single basin nutrient removal facility on the bench adjacent to the existing percolation ponds. Conservation measures and low energy ammonia removal processes were also evaluated.

Single Basin Nutrient Removal Facility

The selected alternative was the single basin nutrient removal process. This facility would include geo-fabric lined earthen aeration basin for operation during the visitor season, and a smaller concrete-lined basin for winter operation. Both basins would be followed by secondary clarifiers. The facility would operate in an extended aeration mode with nitrification and denitrification. Associated equipment would include headworks and septage equipment, blowers, waste activated sludge (WAS) and return activated sludge (RAS) pumps, standby generator, and drying beds. Two of the existing percolation/evaporation ponds would be converted to aeration basins and a sludge holding lagoon. The remaining ponds would be used for effluent discharge to the surrounding aquifer. Future ponds could be constructed adjacent to the existing facility.

The existing effluent pump station would be converted to a raw wastewater pump station by replacing the existing pumps with non-clog wastewater pumps. The existing sewage grinder could be relocated to the pump station. A Stand-by generator would provide emergency power for the pump station.

The existing forcemain between the pump station and the percolation/evaporation ponds runs through a wetlands meadow surrounding Iron Springs Creek, and is in need of repair. The forcemain will be relocated across the existing ball fields and up the access road. This alignment avoids

environmental impact during construction, as well as reducing potential wastewater discharges should a line break occur in the future.

The selected alternative's summary estimate of probable cost is as follows:

Table 1-1 Single Basin Nutrient Removal - Estimate of Probable Cost

Item	Item Cost
Construction Subtotal	$4,423,450
Contingency (10%)	$442,345
Project Supervision (5%)	$221,173
Engineering design (10%)	$442,345
Construction phase service (6%)	$265,407
TOTAL	**$5,794,720**

Evaluation Summary

Treatment alternatives were evaluated for probability of meeting treatment requirements, capital costs and annual operating costs of the 20-year design life of the facility. All three alternatives could meet treatment requirements. Table 1-2 lists capital and annual operating costs for the alternatives evaluated. The selected single basin process had the lowest capital cost and the lowest overall cost. Annual costs were brought to present worth using a 20 year period at a 10% interest rate. The overall cost was calculated by adding the capital cost with the adjusted present worth annual cost.

Table 1-2 Present Worth Costs

Alternative	Capital Cost	Annual Cost	Overall Cost
Single Basin Facility	$5,794,720	$204,961	$7,539,672
Existing Facility Expansion	$6,521,180	$222,945	$8,419,236
RBC Facility	$7,236,538	$201,232	$8,949,742

Collection System Rehabilitation

Although collection system rehabilitation is outside the scope of the proposed project, repair items were identified in the course of the data-gathering phase of the treatment alternative report. The recommended work is discussed in Section 5. One section of Line "E" which runs between the Lodge and Old Faithful geyser is in need of replacement. Additionally, the Inn and Lodge lift stations are recommended to be retrofitted with wet well/ dry pit pump systems. Preliminary investigation shows the Line "E" section could be eliminated by sizing the Lodge lift station to include these flows, and running a new line around the south of the Lodge to tie into the collection system in the parking lot. The summary estimate of probable cost is as follows:

Table 1-3 Collection System Rehabilitation - Estimate of Probable Cost

Item	Item Cost
Construction Subtotal	$425,000
Contingency (10%)	$42,500
Project Supervision (5%)	$21,250
Engineering design (10%)	$42,500
Construction phase service (6%)	$25,500
TOTAL	**$556,750**

Section One Abbreviations

BOD	Biochemical oxygen demand
MGD	Million gallons per day
RBC	Rotating biological contactor
TSS	Total suspended solids
WWTP	Wastewater treatment plant

Project Background

Old Faithful is one of the major developments (villages) in Yellowstone National Park. The Old Faithful development provides services for day visitors, destination visitors, and the support staff who maintain these services for the visitor. Old Faithful provides full service accommodations, similar to any small town including meals, overnight lodging, and gas stations. It is a major destination for most visitors who come to see Yellowstone National Park. There are several seasons at Old Faithful: the visitor season of June through September; the Winter season of December through March; the Spring shoulder season of April and May; the Fall shoulder season of September and October. The Old Faithful development is closed to the public during a six week period starting in March and again during a six week period starting in November. A growing portion of visitors visit this village during the shoulder seasons in the Spring and Fall.

Water and wastewater treatment systems have evolved with the development of the village, with the first systems incorporated into the construction of the Old Faithful Inn in 1903. Several modifications and upgrades have occurred since then, with the last large expansion of the wastewater treatment plant being completed in 1976. The wastewater plant is located nearly a mile to the west of Old Faithful geyser. Expansions and modifications have been foot printed over the original facility. With ever increasing visitation and necessary expansion of staff to accommodate this increase, employee facilities including housing and administrative support buildings presently encroach on the existing wastewater treatment facility. The facility is operating at maximum capacity and occasionally subjects nearby occupants to unpleasant odors.

Existing Wastewater Treatment Facility

The existing wastewater treatment plant (WWTP) was constructed to augment the septic tank system. The secondary treatment mechanical facility provides treatment during the visitor season. Off-season wastewater flows are treated through the septic tank system. Effluent from both treatment systems are pumped to evaporation/ percolation ponds for groundwater discharge.

Since year round operation started in the late 1960's, winter use at Old Faithful has steadily increased. The average off-season wastewater flows in 1970 were 10,000

gallons per day. The septic tank volume of 48,000 provided four days of detention time at that flow rate. During 1996, winter day wastewater flows averaged 100,000 gallons per day, which corresponds to a 0.5 day detention time. The minimum recommended detention time is 1.0 day.

Septic tank treatment consists of settling of solids. Scum and grease float to the surface and are retained in the tank by a baffle. Septic tank effluent containing soluble waste concentrations is then pumped to the evaporation/percolation ponds. The septic tank solids, scum and grease retained during the off-season are processed through the plant the following visitor season.

The mechanical facility consists of a head works, aeration basins, secondary clarifier, chlorine contact basin, effluent pumping station, and sludge drying beds. The existing facility can be operated in contact stabilization or extended aeration mode. The aeration basins include a contact aeration tank (CAT) and a reaeration tank (RAT), with piping to allow either mode of operation.

Table 2-1 lists the design parameters developed for the existing mechanical WWTP, including flows and organic loadings.

Table 2-1 Existing WWTP Design Parameters

Parameter	Quantity
Design Population	5,500 people
Average Flow (Q_{avg})	0.51MGD
Peak Flow (Q_{peak})	1.2 MGD
Biochemical Oxygen Demand (BOD_5)	1,378 lb/day
Total Suspended Solids (TSS)	1,350 lb/day
Emergency Storage (Existing Septic Tank)	48,000 gallons

Table 2-2 lists the design criteria for the existing mechanical WWTP.

Table 2-2 Existing WWTP Design Criteria

Process	Equipment	Quantity	Capacity
Control Building Pump Station			
	Raw Sewage Pump	2	900 gpm
	Raw Sewage Pump	1	250 gpm
Contact Aeration Tank (CAT)		2	31,875 gal ea
	Air supply	1	975 cfm
	Sludge Return Pumps	2	400 gpm
Re-Aeration Tank (RAT)		4	174,250 gal ea
	Air Supply	1	975 cfm
	Sludge Return Pumps	2	400 gpm
Clarifier		1	84,597 gal
	Overflow Rate @ design Q		400 gpd/ft^2
	Overflow Rate @ peak Q		950 gpd/ft^2
	Diameter		40 ft
	Sidewater Depth		9 ft
Aerobic Digester		1	15,072 gal
	Diameter		40 ft
	Sidewater Depth		40 ft
	Air Supply		60 cfm
Chlorine Contact Tank		1	16,788 gal
	Effluent Pumps	2	900 gpm
	Chlorine (gas) Feed Rate		200 lb/day
Sludge Beds			10,500 ft^2
Aeration Blowers		1	1,500 acfm
		1	750 acfm
		1	750 acfm
Percolation-Evaporation Beds			3.77 acres
	Number of Cells	6	

The seasonal operation of the mechanical facility requires the mixed liquor to be drained from the aeration basins at the end of the visitor season. Plant start-up each May requires developing a viable biomass from the dilute concentration of microorganisms in the influent waste stream. These microorganisms are typically

fast growing, which result in a light density sludge which settles poorly. Time is required for the microorganism population to evolve into dense, well settling mixed liquor. Typically, 2 or 3 sludge ages are required. At a design sludge age of 15 days, it requires 30 to 45 days from start-up before adequate treatment efficiency can be achieved.

Old Faithful is world renown for the geothermal activity in the area. The warm groundwater warms collection system pipes, maintaining the wastewater temperature in the 25 to 27°C range year round. These warm water temperatures increase the kinetics of the microorganisms, including the nitrifying microorganisms *Nitrosomonas* and *Nitrobacter*. These organisms convert ammonia in the wastewater to nitrate. Heterotrophic bacteria under the anoxic conditions found in the secondary clarifier then convert the nitrate to nitrogen gas. As the nitrogen gas is released to the atmosphere, it carries sludge particles to the surface of the clarifier. The resulting floating sludge requires an undue amount of operator attention to prevent solids discharge into the effluent pump station wet well.

Flow data for the 1996-97 was reviewed. Wastewater flows are measured in a parshall flume by an ultrasonic sensor, and continuously recorded on a chart recorder. These reported flows are compared to the influent pump operating hours (multiplied by the pump's rated flow). Recorded wastewater flows appear to be accurate, although they are typically 30% to 50% less than the corresponding amount of water supplied to the system. This is the result of the area's unique geothermal character. Water is wasted from the water system to cool the lines to maintain cold water delivery temperatures. Table 2-3 lists recorded wastewater flows from fiscal 1997 flow data. Recent annual reports containing flow data are included in Appendix A. Peaking factors were developed from the flow records. As determined from comparison of peak day vs. monthly average wastewater flow data from June through August 1997, a peaking factor of 2.4 was used to estimate peak flows. The maximum 30-day average flow was 0.356 MGD. The peak daily flow was 0.854 MGD. Both events occurred during the month of June.

Another operating concern is the varying flows over the year. During the main visitor season of June through September, the daily flows were in the 0.300 to 0.500 MGD range. During the off-season of December through March, the daily flows were in the 0.100 MGD range. In the months between these two seasons, the daily flows were between 0.010 and 0.020 MGD.

Table 2-3 Wastewater Average Daily Flows for Fiscal 1997

Month	Average Flow (MGD)	Peak Flow (MGD)
October	0.107	0.2568
November	0.035	0.084
December	0.276	0.1008
January	0.049	0.1008
February	0.042	0.1008
March	0.032	0.0768
April	0.287	0.2016
May	0.213	0.6888
June	0.287	0.6336
July	0.287	0.6888
August	0.276	0.6888
September	0.209	0.5016
Minimum	0.032	0.0768
Maximum	0.287	0.6888

The WWTP discharges to groundwater through evaporation/percolation ponds on a bench above Iron Springs Creek, to the west of the WWTP. As part of the WWTP project in 1973, groundwater monitoring wells were installed between the ponds and the creek. Monitoring results indicate the groundwater is starting to contain elevated levels of nitrate and chloride.

The mechanical plant nitrifies, as evidenced from the floating sludge on the secondary clarifier, during certain times in the latter part of the summer. During this time, partial nitrate removal is occurring at the mechanical facility. This nitrogen conversion reduces the nitrogen loading to the ponds. The other months the mechanical plant is on-line, the secondary effluent contains ammonia which is discharged to the percolation ponds. During the months the plant is off-line, septic tank effluent is pumped directly to the ponds. This partially treated wastewater contains significant concentrations of ammonia. Under these conditions, nitrification might be occurring in the soil, resulting in nitrate being discharged to the groundwater. In addition to ammonia, septic tank effluent typically has chloride concentrations 100 times more concentrated than secondary effluent.

Selected groundwater monitoring data is listed in Table 2-4. Additional groundwater monitoring data is included as Appendix B. Figure 2-1 through 2-4 show the location of the monitoring wells relative to the evaporation/percolation ponds and nitrate concentration gradients from recent monitoring. Lines of equal concentration (LOCs) were drawn for the mean of the concentration limit and the 90th percentile of the upper concentration limit.

Figure 2-1 - Old Faithful - 1994 Groundwater Monitoring - Nitrate

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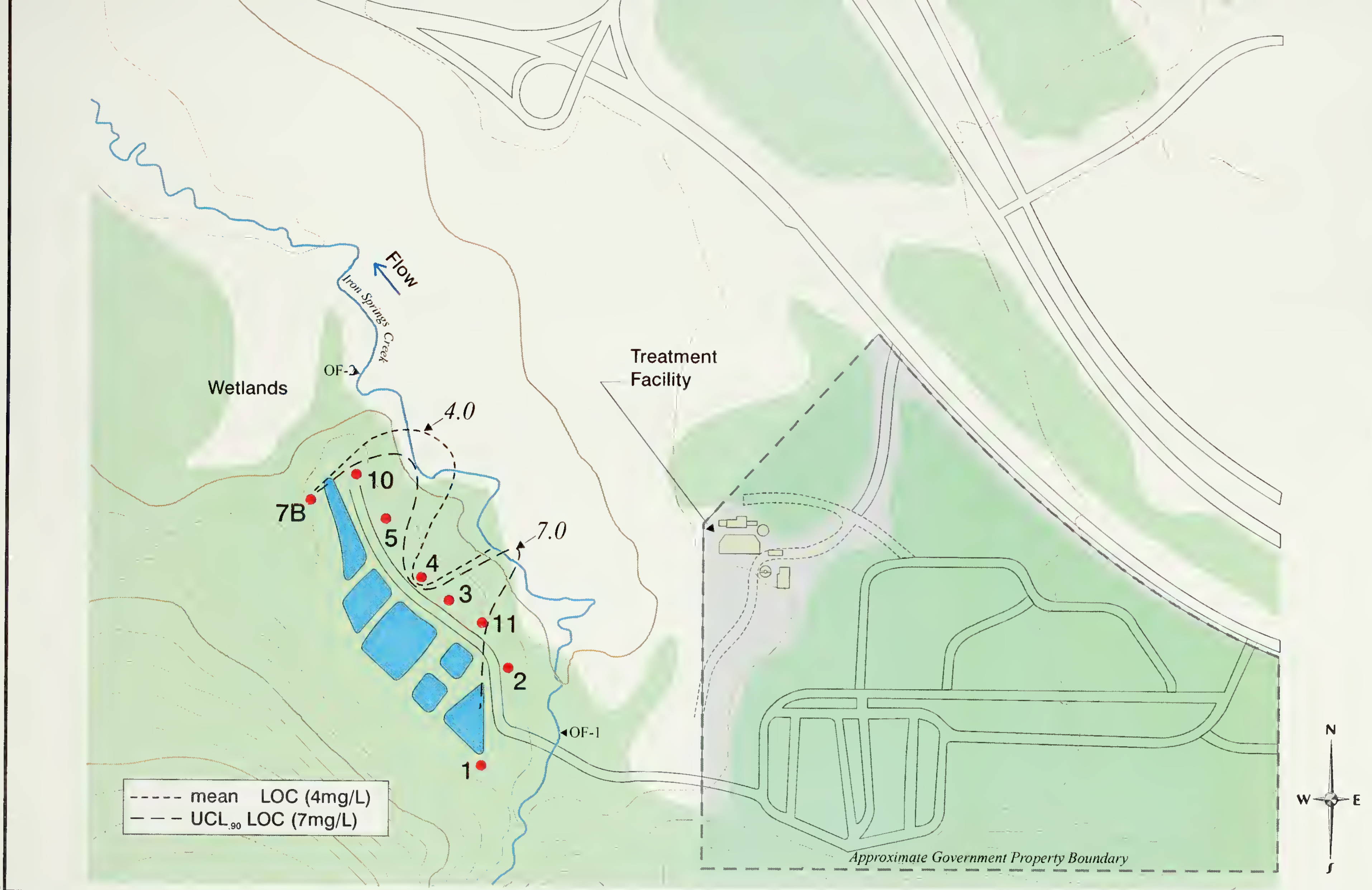

Figure 2-2 - Old Faithful - 1995 Groundwater Monitoring - Nitrate

Rothberg, Tamburini & Winsor, Inc.

10 31 97 1839-SC Canyon Village

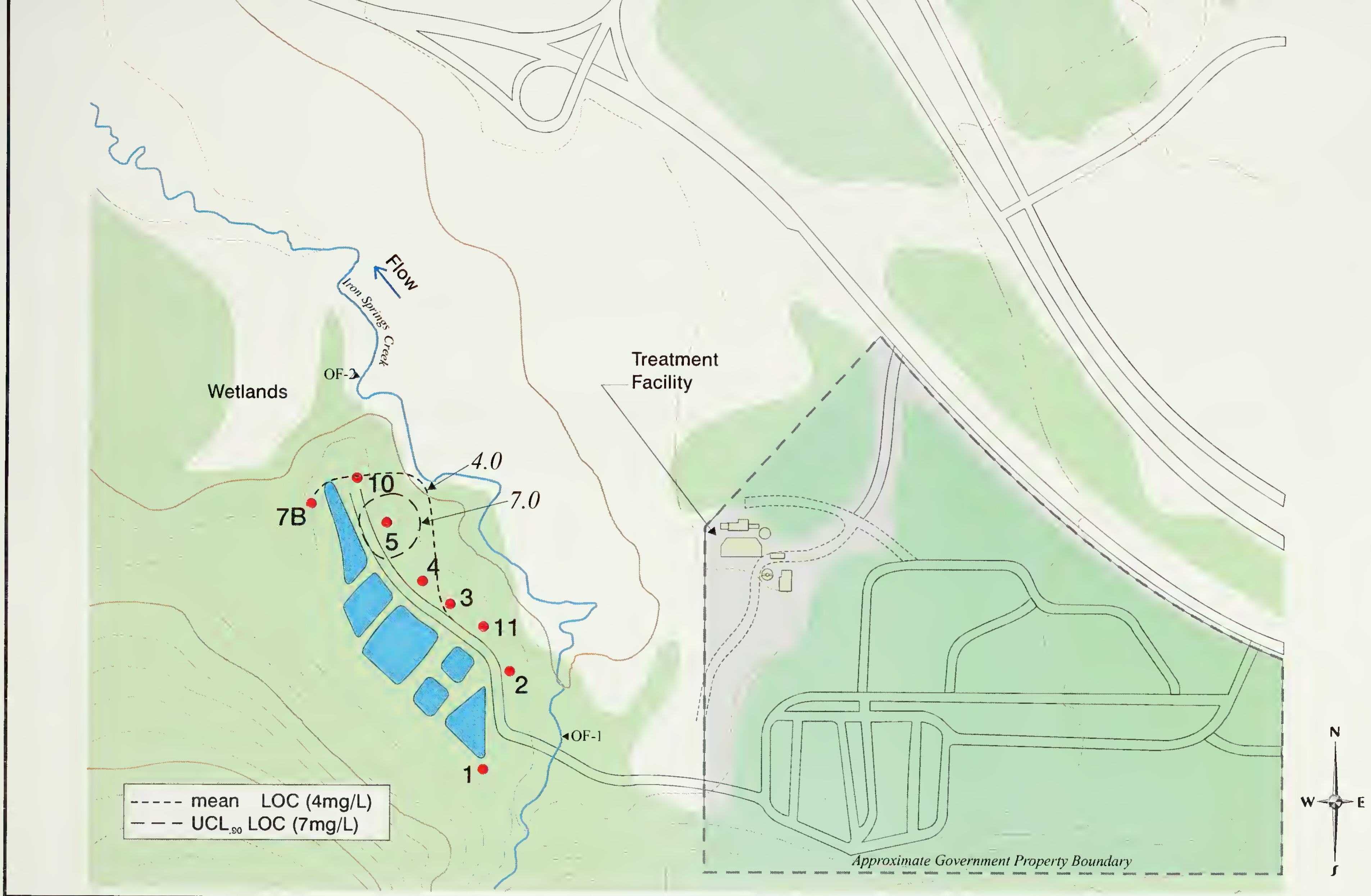

Figure 2-3 - Old Faithful - 1996 Groundwater Monitoring - Nitrate

Rothberg, Tamburini & Winsor, Inc.

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Figure 2-4 - Old Faithful - 1997 Groundwater Monitoring - Nitrate

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06 24 98 1839 Fig2 4 cdr

Table 2-4 Groundwater Monitoring - Nitrate

Year	Upstream	Well 1	Well 2	Well 3	Well 4	Well 5	Well 7b	Well 10	Well 11	Downstream
1974	0.01	0.03	8.5	0.61	0.13	0.23	–	–	–	–
1985	0.01	–	0.18	3.4	0.7	3.6	2.9	–	–	0.01
1985	0.05	0.05	0.32	8.6	0.71	7.2	5.6	–	–	0.05
1990	0.01	0.07	3.6	0.85	1.6	3.3	6.5	–	–	0.01
1993	0.10	0.10	2.16	2.42	2.79	41.8	0.38	–	–	0.10
1990	0.01	0.05	2.33	6.16	5.28	7.47	25.0	18.5	24.2	0.01
1995	0.05	0.06	0.79	–	1.11	14.6	0.13	8.42	19.5	0.05
1996	<0.10	<0.10	<0.10	2.34	5.20	9.95	0.10	4.16	0.84	<0.10
1997	<0.10	<0.10	0.23	3.73	2.53	10.9	<0.10	6.35	0.94	<0.10
Min	0.01	0.03	0.1	0.61	0.13	0.2	0.1	4.2	0.8	0.01
Max	0.05	0.1	8.5	8.6	5.28	42	25	19	24	0.1

As seen from the figures, in 1994 the mean LOC plume reached from the upstream sampling point, under Iron Springs Creek, to Well 1. Sampling during 1995 showed a plume radiating from Well 5 and Well 11. Sampling during 1996 showed a plume radiating from Well 5, with a 9.95 mg/L nitrate concentration at the well. Sampling during 1997 showed a plume radiating from Well 5, with a 10.9 mg/L nitrate concentration at the well. Both the mean LOC (4 mg/L) and the 90th percentile upper concentration limit (7 mg/L) lines are shown. Based on this data, the nitrate concentrations below Iron Springs Creek are approaching the limit for nitrate.

Water, Sewer & Power

The existing line between the plant's effluent pump station and the percolation ponds runs through the meadow, which is primarily a wetlands, and under Iron Springs Creek. The line is in poor condition, including a temporary repair where the line crosses the creek.

The existing mechanical plant has water service. A water supply line also runs through the Iron Springs Creek meadow to the percolation pond area. The existing line is broken somewhere in the wetland area and is out of service.

The existing plant has three phase power. The percolation pond area has single phase power. A power supply transformer is located at the edge of the government trailer court, approximately 3,000 ft from the percolation ponds. High voltage

power lines bring power to the transformer from the north and run along the northern edge of the percolation pond area.

Section Two Abbreviations

acfm	Actual cubic feet per minute
BOD_5	Biochemical oxygen demand
CAT	Contact aeration tank
cfm	Cubic feet per minute
DEQ	Wyoming Department of Environmental Quality
gal	Gallons
gpd	Gallons per day
gpm	Gallons per minute
lb/day	Pounds per day
LOC	Lines of equal concentration
MGD	Million gallons per day
mg/L	Milligrams per liter
NPS	National Park Service
Q_{avg}	Average flow
Q_{peak}	Peak flow
RAT	Reaeration tank
TSS	Total suspended solids
WWTP	Wastewater treatment plant

Wastewater Treatment Facility Alternatives

The Old Faithful village is experiencing gradually increasing visitor numbers and subsequent increases in wastewater flow. Currently, the mechanical facility is operated from mid-May to late September. The septic tanks are operated the other time. Throughout the year, effluent is pumped to the evaporation/percolation ponds for subsurface disposal. As neither treatment process is designed to remove ammonia consistently, nitrogen is discharged throughout the year, resulting in degradation of the surrounding groundwater aquifer. This section addresses treatment alternatives which are sized for the projected flows and consistently remove ammonia and nitrate prior to discharge to the groundwater.

Future flow and loading estimates were developed from review of operating data and information obtained from transportation reports prepared for Yellowstone National Park. The report Transportation Study - Dunraven Road (BRW, 1997) identified growth trends in recreation visits to Yellowstone. Annual visitation increased from 2 million in 1980 to 3.125 million in 1995, for a 3% annual increase. Since 1990, the growth rate has trended downward. The NPS Public Use Statistics Branch projects that the growth rate will continue to decline, reaching about 1% per year by 2010. Figure 3-0 shows the NPS's growth projections, which were used to estimate future flows. The report Alternative Transportation Modes Feasibility Study (BRW, 1994) identified current (1994) winter season visitation to be 3% of the total annual visitation, or about 90,000 people between Jan and April. Table 3-1 lists projected wastewater flows for both seasons. The flows were estimated by projecting the 1997 average monthly wastewater flows by the growth percentages presented in the referenced transportation reports.

Figure 3-0 Projected Annual Growth Rate

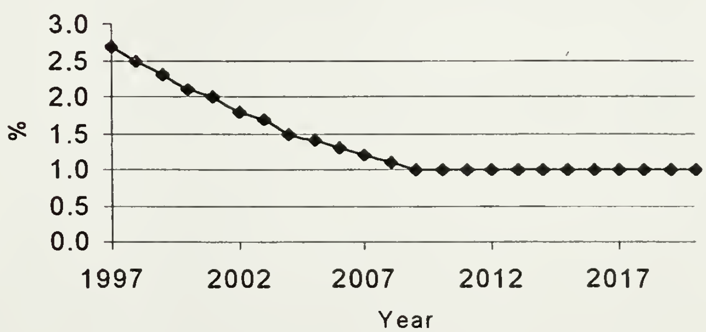

Table 3-1 Projected Flows

Year	Season Projected Growth Max 30-d Average WWT Q (gpd)	Projected Growth Max 30-d Peak WWT Q (gpd)	Off-Season Projected Growth Max 30-d Average WWT Q (gpd)	Projected Growth Max 30-d Peak WWT Q (gpd)
1997	0.287	0.689	0.049	0.118
1998	0.350	0.840	0.050	0.121
1999	0.358	0.866	0.052	0.124
2000	0.356	0.877	0.059	0.124
2001	0.373	0.866	0.054	0.129
2002	0.380	0.911	0.055	0.132
2003	0.386	0.927	0.056	0.134
2004	0.392	0.940	0.057	0.134
2005	0.397	0.954	0.058	0.139
2006	0.402	0.966	0.059	0.141
2007	0.407	0.978	0.059	0.142
2008	0.412	0.988	0.060	0.144
2009	0.416	0.998	0.061	0.145
2010	0.420	1.009	0.061	0.147
2011	0.424	1.018	0.062	0.149
2012	0.429	1.028	0.059	0.150
2013	0.433	1.039	0.063	0.152
2014	0.437	1.049	0.060	0.150
2015	0.442	1.060	0.060	0.156
2016	0.446	1.070	0.065	0.156
2017	0.450	1.081	0.066	0.158
2018	0.455	1.092	0.066	0.159
2019	0.459	1.103	0.067	0.161
2020	0.464	1.114	0.068	0.163

The estimated build out maximum monthly flow for the visitor season was 0.464 MGD. The estimated build out maximum monthly flow for the winter season was 0.068 MGD. This projected capacity is slightly less than the current permitted capacity. Therefore, the permitted capacity of the facility will remain at 0.51 MGD.

As discussed later in this section, major rehabilitation of the treatment plant is driven by changing treatment requirements rather than increased capacity requirements. Based on groundwater monitoring data, the aquifer adjacent to the WWTP has increasing nitrate and chloride concentrations. The only nitrate and chloride source identified in the area is the WWTP's effluent. Under the federal pollution elimination system, the WWTP would be required to remove nitrate and chloride from its effluent prior to discharge into the aquifer. Therefore, all alternatives evaluated would provide nutrient removal.

The following treatment alternatives are evaluated in this section:

- Conservation Methods
- Expansion of the existing facility at the present site
- Construction of a new facility on the bench adjacent to the evaporation/percolation ponds. Two treatment process were evaluated for the new facility:
    - Rotating Biological Contactors (RBCs)
    - Single Basin Nutrient Removal Process

Table 3-2 lists design criteria established for sizing the treatment alternatives.

Table 3-2 Treatment Alternative Design Criteria

Parameter	Capacity	Units
Visitor (Summer) Season 30-day Average Flow ($Q_{max\ 30\text{-}d\ avg}$)	0.510	MGD
Peak day Flow (Q_{peak})	1.2	MGD
Shoulder (Winter) Season 30-day Average Flow ($Q_{max\ 30\text{-}d\ avg}$)	0.068	MGD
BOD_5 (90th Percentile)	440	mg/L
BOD_5 (90th Percentile)	1871	lb/day
TSS (90th Percentile)	350	mg/L
TSS (90th Percentile)	1489	lb/day
Ammonia (90th Percentile)	40	mg/L
Ammonia (90th Percentile)	440	lb/day
Effluent BOD	30	mg/L
Effluent TSS	30	mg/L
Effluent Nitrate	<10	mg/L

Conservation Measures

As discussed previously in this section, the projected wastewater flows do not exceed the current hydraulic capacity of the treatment facility. Water conservation measures have been in place at the village's visitor facilities for some time. New visitor facilities are being built to replace old facilities. These new facilities are designed under current National Park Service sustainable design guidelines and include energy conservation measures as building insulation and low flow fixtures.

Conservation measures decrease wastewater volume, but not organic loading. This is shown in the increase in BOD concentration between the existing facility's design drawings and current operating data. In the 1973 drawings, the organic loading was based on a BOD concentration of 325 mg/L. Current operating data were used to develop the design criteria listed in Table 3-2, including a 90th Percentile BOD concentration of 440 mg/L. Treatment processes are sized to treat the pounds of organic matter in the waste stream. Therefore, increasing conservation measures in the visitor facilities would not decrease the size of the treatment facilities.

Low energy treatment options were reviewed for nutrient removal: constructed wetlands or floating aquatic plant treatment systems. These systems require large land area, warm climates, and use non-native plants. Additionally, the groundwater contains various minerals. Extensive piloting would be required to determine the minerals effect on treatment efficiency. It was determined these treatment options were not conducive to Yellowstone's climate, or the Park's policy on flora conservation, and were not considered further.

Rehabilitation of Existing Facility

The permitted capacity would remain at 0.51 MGD maximum average daily flow and 1.2 MGD maximum peak daily flow. The aeration basins would be expanded to increase the hydraulic detention time to incorporate nitrification and denitrification into the treatment process. The design hydraulic detention time for extended aeration with nitrification is 16 hours. At a design flow rate of 0.51 MGD, the minimum aeration basin volume required is 0.34 MG, or 100,000 gallons more that the existing 0.24 MG aeration basin volume. Because the plant will nitrify, additional aeration basin volume will be added to provide anoxic zones in the aeration basin for denitrification. The total aeration basin volume required is approximately 0.50 MG. Figure 3-1 shows a sketch of the expanded facility.

The secondary treatment process currently used at Old Faithful is an aerobic process designed to provide 1.5 lb oxygen for every pound of BOD removed. Additional aeration would be required at a rate of 4.6 lb oxygen for every pound of ammonia

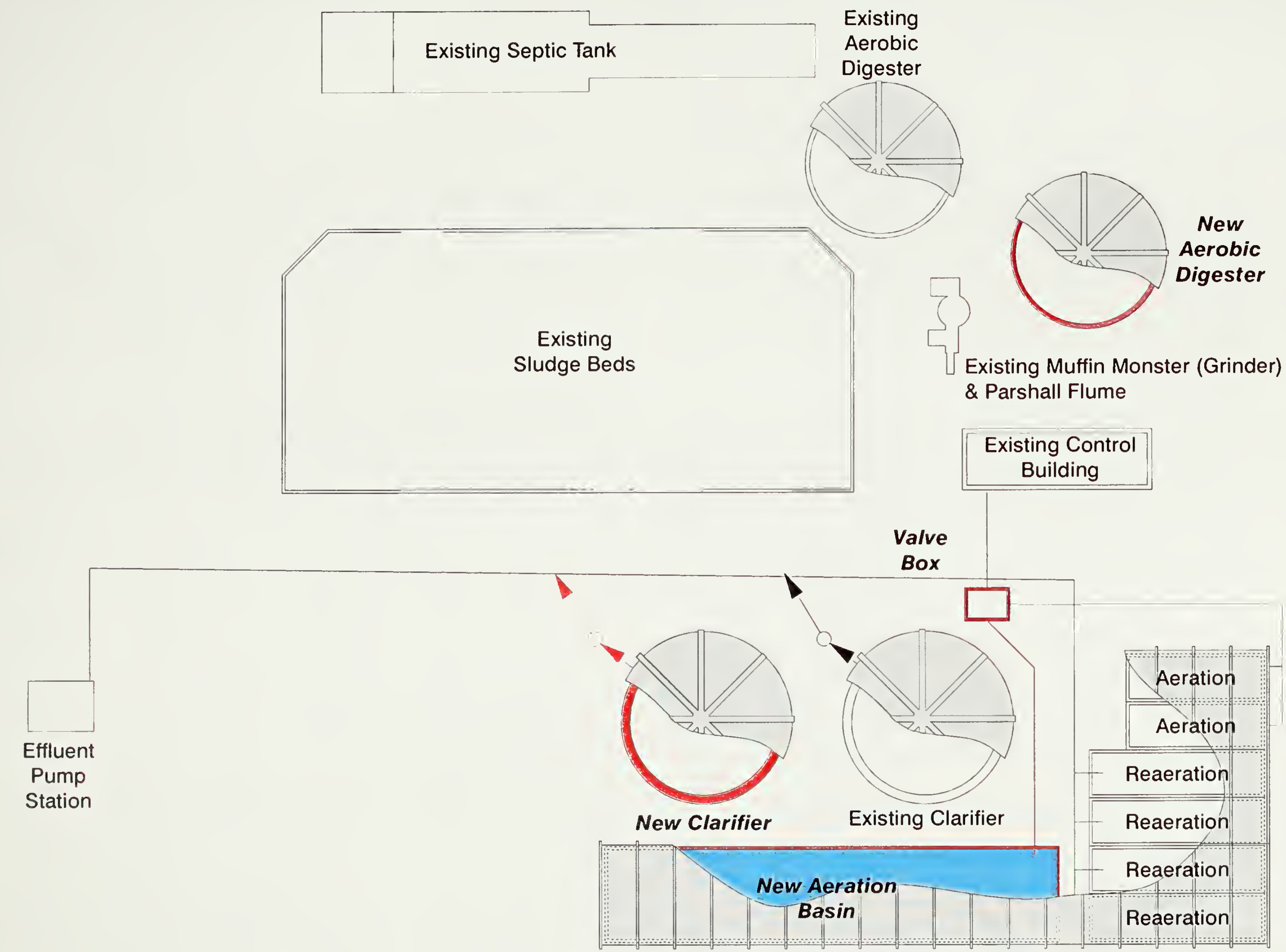

Figure 3-1 - Expansion of Existing Facility

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converted to nitrate. At the design flow of 0.51 MGD, this oxygen demand requires a delivered air volume of 3,000 acfm, or increased air delivery capacity of approximately 1,500 acfm.

The existing secondary clarifier is 40 feet in diameter (1,257 ft^2 surface area), with a side water depth of 9 feet at a design surface overflow rate (SOR) of 400 gpd/ft^2. This clarifier meets the hydraulic and solids loading sizing criteria for a summer max average flow of 0.51 MGD. During the winter the clarifier would be oversized, leading to operational problems as bulking and rising sludge. Additionally, Wyo DEQ requires two treatment units for new and expanded plants with over 100,000 gpd capacity. It is recommended an additional 25 ft diameter clarifier with 12 ft side water depth be added. This clarifier could be loaded at 1400 gpd/ft^2 for peak flow conditions which would be created by taking the 40 ft^2 clarifier off-line for maintenance. The clarifiers could be operated in parallel during the peak flow periods.

The design standard for sludge return pumping capacity is 1.5 times the maximum average 30-day flow. For this facility, a pumping capacity of 550 gpm is required. The existing return pumps provide 400 gpm. Adding an additional pump of similar capacity and operating the two pumps in parallel would provide the required capacity.

Effluent would continue to be pumped to the existing evaporation/percolation ponds. Modifying the facility to include denitrification is intended to minimize the nitrate concentrations introduced into the groundwater aquifer during percolation.

Solids are generated as a result of BOD and ammonia conversion at a rate of 0.3 to 0.8 lb solids/lb BOD removed. Assuming 7% solids in the waste stream, the maximum estimated sludge volume during the visitor season is 3,400 gallons per day. During the off-season, the maximum 30-day average flow is estimated to be 0.068 MGD. Assuming the same BOD and sludge production, the sludge volume would be 820 gallons per day. These solids are removed from the treatment system as wasted sludge to the aerobic digester. Operating the facility during the winter would require additional sludge storage.

The current off-season treatment approach would be discontinued due to the limited treatment provided by the septic tanks. Modification of the Old Faithful facility would include provisions to provide secondary treatment with nitrogen removal throughout the year. Nitrification kinetics at the lower winter temperatures decreases, resulting in longer required solids retention time (SRT) in the aeration basin. Increasing the design HRT to 24-hr for an off-season flow rate of 0.068 MGD would require 0.068 MG aeration volume and one clarifier on-line. Winter conditions of freezing weather and snow accumulation would require enclosing the aeration basin, clarifiers, and sludge pumps.

Covering the process basins would provide an added benefit of odor control. However, it is believed that the sludge drying beds contribute more to the identified odor problem than the secondary treatment process. Odor is produced during the dewatering process due to anaerobic decomposition of the sludge solids. The existing drying beds are used to dewater sludge by pumping dilute, partially-digested sludge at approximately 1% solids directly to the beds from the aerobic digester. Water is decanted from the beds and returned to the plant. The sludge is reworked by mechanical means to accelerate the dewatering process. Final dewatering is by evaporation. This current method of solids drying leads to significant unpleasant odors. Because the wastewater facility is located in close proximity to the employee housing and an employee recreation area, the odors generated by this sludge handling process present an operations problem for the facility.

Modifications of the existing facility would include improved odor control for the drying beds. The existing drying beds have a paved surface and PVC under drain system. Because the drying bed process uses sunlight and wind for dewatering, it is not feasible to use the conventional form of odor control, i.e., providing enclosure and deodorizing the air. Because the major cause of odor in drying beds is moisture, the recommended approach to decrease odor is to apply thicker solids to the beds. Odors generated tend to be the strongest when the sludge is drying in the 5 to 15% solids range. In this recommended solids treatment approach, digested solids would be concentrated to approximately 16% through a centrifuge or belt press prior to air drying. Furthermore, these thickened solids would then be mixed with previously dried solids (75% solids). Facility modifications required for this process include installation of a solids handling facility for thickening, and increasing the drying bed area to allow for dried solids storage. Although this recommended solids treatment approach would reduce odors, it would not eliminate odors completely. The dried biosolids would continue to be disposed of at the Cody, Wyoming landfill.

Advantages and disadvantages of this alternative are presented in the following table.

Table 3-3 Advantages and Disadvantages of Expanding the Existing Facility

Advantages	Disadvantages
Minimal pretreatment required	Higher daily process control
Reliable BOD, TSS, and nitrogen removal over varying flows	Aesthetic issues if uncovered: visual and odor
	High cost
	Increased solids handling and odor control
	High power consumption

Relocating Treatment Facilities

The Old Faithful facility has land available adjacent to the evaporation/percolation ponds which would allow the construction of a new facility. The existing effluent pump station could be converted to a raw sewage pump station. Emergency storage would be provided by converting the existing chlorine contact chamber (16,788 gallons) to a holding tank. At design flow of 0.510, the contact chamber would provide 45 minutes of emergency storage. Wyoming DEQ regulations require stand-by power or 24 hours of emergency storage volume at design flow. Stand-by power generation coupled with the 45 minute storage volume would meet the regulations at a smaller capital cost than installing tankage.

Additional work associated with moving the facility to the evaporation/percolation pond bench includes replacing the existing effluent line between the treatment plant and the evaporation ponds, replacing the water line, and bringing three phase power to the site. The effluent and water lines currently run through a wetlands surrounding Iron Springs Creek and are in need of repair. The lines will be rerouted up the road to the bench to eliminate the environmental impact of construction and to provide maintenance access.

Four of the evaporation/percolation ponds would be kept in service for subsurface discharge. Percolation rates of the ponds are expected to decrease over time, and additional pond volume may be required. Additional ponds can be built adjacent to the existing facility, at shown on Figure 3-5.

Alternatives for secondary treatment at the evaporation/percolation pond bench are described below.

Rotating Biological Contactors

A fixed-film treatment alternative for removal of BOD, TSS, ammonia and nitrate is a rotating biological contactor (RBC). This secondary biological wastewater treatment process consists of large-diameter corrugated plastic media mounted on a horizontal shaft and placed in a concrete basin. The media is slowly rotated while approximately 40% of the surface area is submerged in the wastewater. The RBC basins, clarifier, blowers and waste pumps are enclosed in a building. Figure 3-2 shows a process schematic of an RBC nitrifying/denitrification facility. Figure 3-3 shows a cut-away of an RBC basin.

The RBC process requires a more extensive preliminary treatment train than conventional treatment. Large solids and dense particulate matter are removed from the influent wastewater to prevent particulate matter from clogging the RBC media that would result in decreased process efficiency.

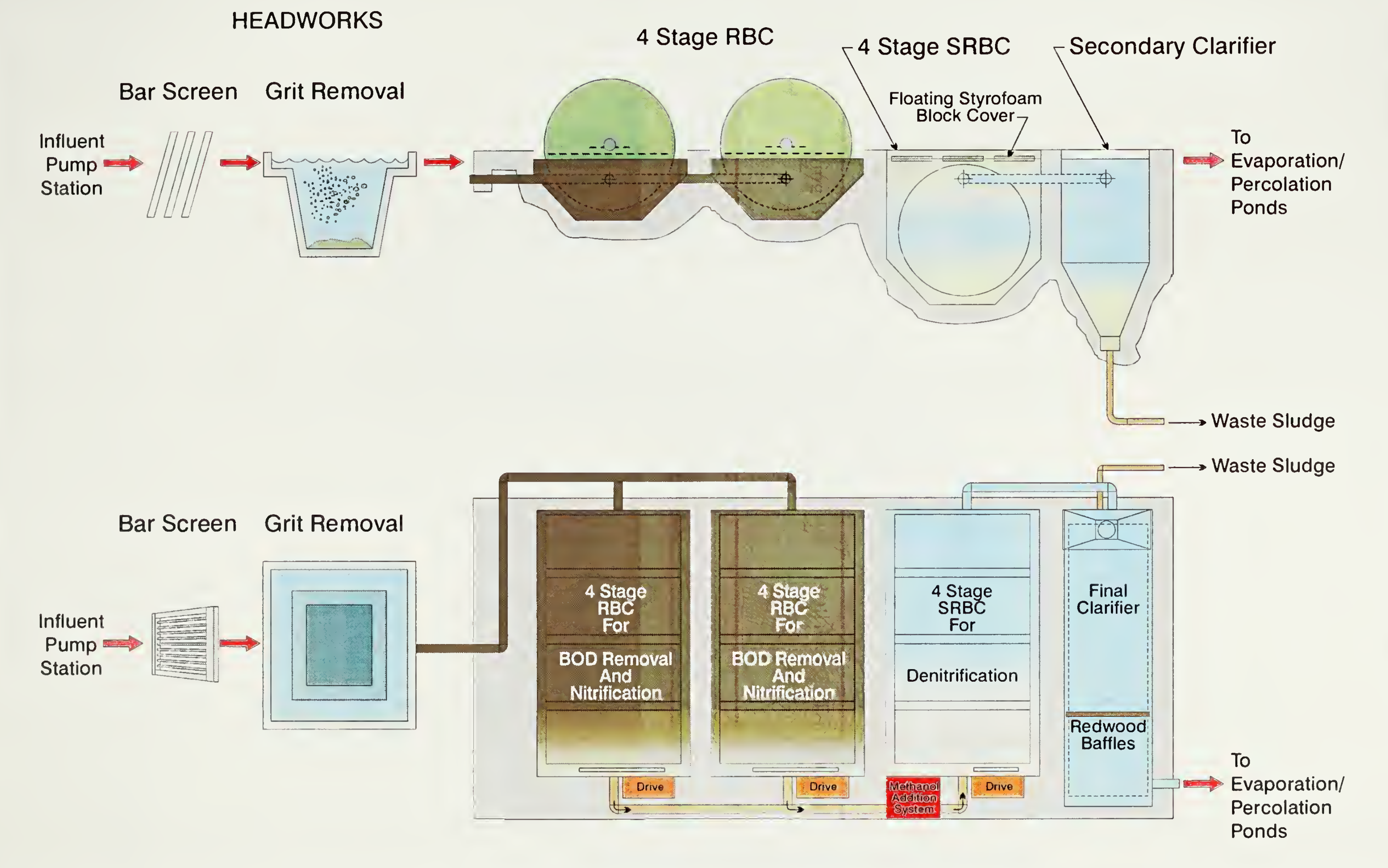

Figure 3-2 - Rotating Biological Contactors (RBC's) Process Schematic

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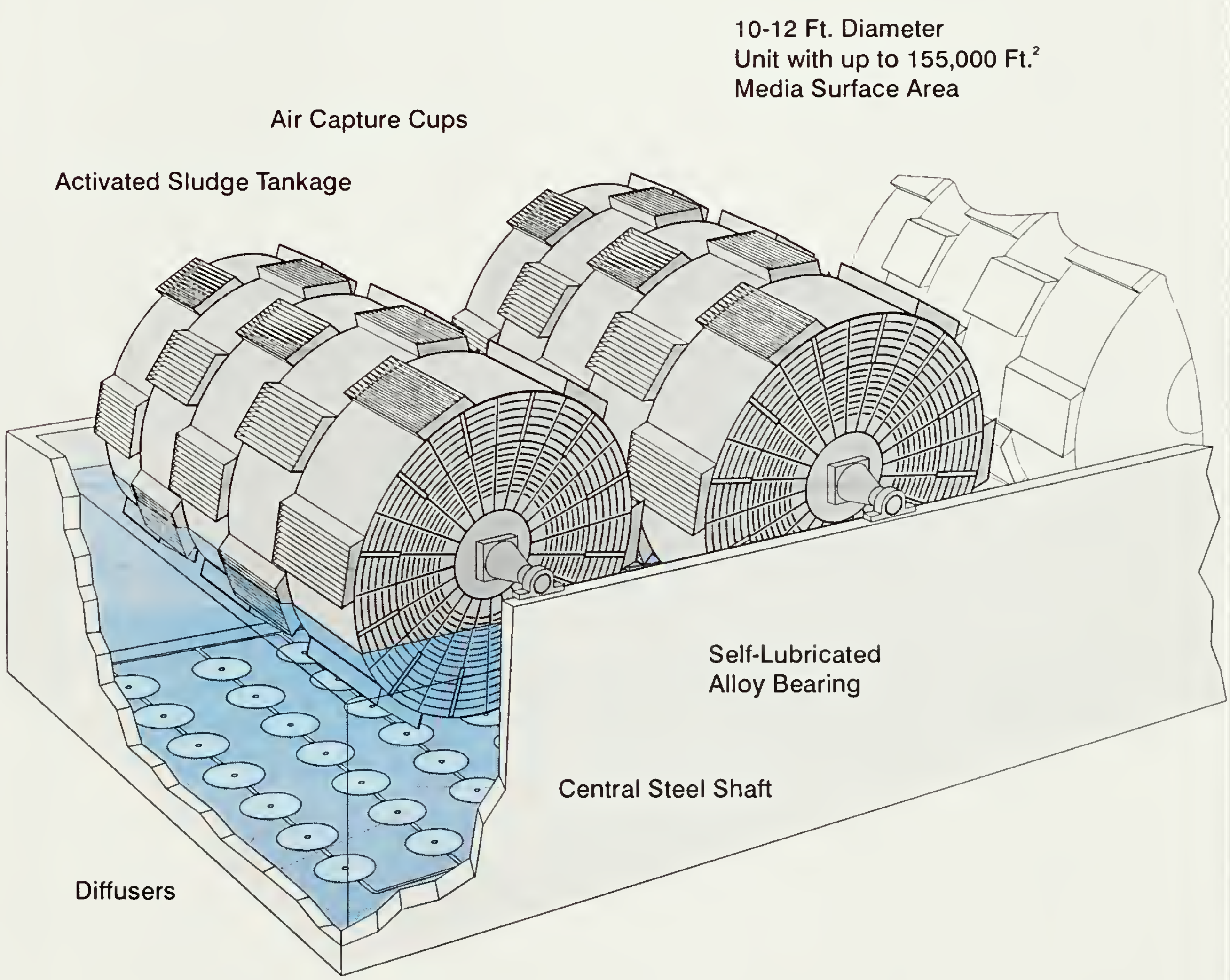

Figure 3-3 - Rotating Biological Contactors (RBC's)

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The headworks facility would include a trash rack to remove coarse solids, a grit chamber to remove inorganic particles, and a fine screen to remove sizable organic material. A fine screen consists of a stationary plane or rotating cylinder fabricated from wedge wire with approximately 0.060 inch spaces between adjacent wires.

The RBC's attached biomass contains approximately 30,000 mg/L suspended solids. The growth contains a mixed biological population of heterotrophs for BOD, TSS, and nitrate removal and autotrophs for ammonia conversion. The continual drag from being rotated through the wastewater and the draining of the entrained wastewater when rotated up into the air cause the growth to form elongated filaments. The surface area of growth is thus much larger than the surface area of the media. In rotation, the media carries the organisms and a film of wastewater into the air where oxygen is absorbed. Organisms in the biomass remove both dissolved oxygen and organic materials from the film of wastewater. Further removal occurs as the media continues rotation through the bulk of the wastewater in the basin.

RBCs are generally configured in stages. Staging is accomplished by using baffles in a single tank, or using separate tanks in series, to compartmentalize the media into a series of independent cells. Multiple shafts can be arranged within a given stage. Each stage of media operates as a completely mixed, fixed-film biological reactor. Treated wastewater and stripped biomass pass through each subsequent stage of media. As wastewater passes from stage to stage, it undergoes a progressively increasing degree of treatment by the different biological cultures which develop in the successive stages.

Air driven RBC shafts have media 12 ft in diameter on 27 ft horizontal shafts. The media is corrugated to create a large surface area on the disk. Standard density media (also known as low-density media) has 100,000 ft^2 of surface area and larger openings between media for increased oxygen transfer. The standard density media is typically used for the RBCs first stage, which has the highest organic loading and thickest biological film. Medium and high density media, 120,000 and 150,000 ft^2 per 27 ft shaft respectively, are used in the middle and final stages where thinner growths occur.

The RBC process for BOD removal is sized for an organic loading of 1.5 lbs soluble BOD per day per 1,000 ft^2 of media. Ammonia removal, down to 5 mg/L, is sized for an organic loading of 0.3 lbs per day per 1,000 ft^2. Ammonia removal to lower concentrations is dependent upon ammonia concentration. Hydraulic loading—detention time in the nitrification stages—is the principal criterion and staging is required. Denitrification can be accomplished by submerging the last stage(s) and operating these stages in an anoxic mode at a reduced rotational speed. The mixed liquor suspended solids concentration flowing to the final clarifier is approximately

equal to the influent suspended solids concentration which will typically vary from 100 to 400 mg/L.

The density and low concentration of the RBC process mixed liquor allows its secondary clarifiers to be sized smaller than conventional activated sludge clarifiers. Solids separation occurs by discrete particle settling without hindered settling or solids compression. The surface overflow rate is the primary design parameter for the RBC clarifier sizing, with a design surface overflow rate of 600 gpd/ft^2. Side water depths for RBC clarifiers are typically 8 to 10 ft, which is generally 2 to 5 ft shallower than clarifiers designed for conventional secondary treatment.

The RBC process produces less sludge than the activated sludge processes evaluated. With an estimated sludge yield of 0.5 lb solids/lb BOD removed, the sludge production during the visitor season would be in the range of 2,000 gallons per day. During the off-season, the sludge production would be in the range of 300 gallons per day.

The RBC process is operated on a once-through basis with no recycle of biosolids or effluent. This equates to uncomplicated process operation and limited control monitoring. Use of simple drive systems at low rotational speeds results in low maintenance requirements. Power consumption is lower than an activated sludge process. The primary drawback to RBCs is their high capital cost due to the significant pretreatment requirements, facility enclosure, and the high cost per gallon of the RBC disks.

The RBC process provides treatment flexibility over highly varying treatment flows. Operation of an RBC plant at low initial flows or during periods of very low flow will yield effluent of higher quality than at design flow. The process lends itself to construction phasing due to modular construction, low hydraulic head loss, and shallow excavation. Advantages and disadvantages of the RBC process, as compared with the other treatment options evaluated, are summarized in the following table.

Table 3-4 Advantages and Disadvantages of the RBC Alternative

Advantages	Disadvantages
Lowest daily process control	Highest capital costs due to: Pretreatment Facility Facility Enclosure Higher cost/gal for RBC disks
Lowest preventative maintenance	
Reliable BOD, TSS, and nitrogen removal over varying flows	
Smaller footprint than Single Basin	Greatest pretreatment requirements
Practical for construction phasing	

Sizing an RBC facility for Old Faithful is estimated to require 700,000 ft^2 of disk media for both carbon oxidation and nitrification. Using a combination

of low, medium, and high density media with unit surface areas of 100,000, 120,000, and 150,000 ft^2 per shaft respectively, the resulting system would be comprised of 2 shafts per stage, equating to a total of 6 shafts. Three stages would be provided to facilitate BOD removal followed by nitrification. Two secondary clarifiers, each approximately 30 feet in diameter, would follow the RBC's for settling. The RBC process requires construction of treatment basins enclosed in a building for temperature control as well as odor control.

Waste activated sludge (WAS) would be pumped into a partially mixed lagoon for biosolids treatment and storage. Canyon Village AWT's floating dredge could be used to pump settled liquid biosolids, containing approximately 2 to 4% solids, to the drying beds. The drying beds would be of similar size as the existing facility (10,500 ft^2). Decant from the pond would be pumped back to the head of the plant. Biosolids would be pumped during the spring, summer and fall months to the drying beds. The lagoon would store solids produced during the winter months when sand bed drying would be less effective.

Assuming the average plant conditions shown in Table 3-5, the estimated pond size required for providing one-year of biosolids storage in the lagoon is 1.2 acre-feet (or 0.4 MG). This capacity could be met by converting part of Pond "F" into a biosolids lagoon. Table 3-6 lists the storage volume for each of the existing evaporation/percolation ponds. If NPS would like to provide additional capacity beyond one-year of storage, it is recommended that an additional lagoon be constructed rather than further reducing the evaporation/percolation pond capacity.

Table 3-5 Design Parameters Used to Estimate Biosolids Storage

Parameter	Value
Average visitor season flow, Q	0.510 MGD
Average off-season flow, Q	0.068 MGD
Average BOD, BOD_{avg}	250 mg/L
Yield	0.5 lbs solids/lb BOD
Solids concentration[1]	7%

[1] Estimated average concentration in the lagoon

Table 3-6 Existing Capacities of the Evaporation/Percolation Ponds

Pond No.	Surface Area (acres)	Water Depth (feet)	Storage Volume (acre-feet)
A	0.65	1.1	0.72
B	0.60	2.5	1.5
C	1.16	4.5	5.22
D	0.34	5.5	1.87
E	0.33	5.5	1.82
F	0.35	5.0	4.25
Totals:	**3.93**	**N/A**	**15.3**

Single Basin Nutrient Removal Process

A second treatment alternative is the modification of an aerated lagoon system to a single basin nutrient removal process. Although conventional aerated lagoons provide reliable BOD and TSS removal, these systems do not provide reliable ammonia removal due to the lower microorganism concentration maintained in the aerated lagoon. Figure 3-4 shows a single basin facility site layout. Figure 3-5 shows a process schematic.

The single basin process is an improvement to an aerated lagoon system in that it provides reliable ammonia removal along with BOD and TSS removal. The process consists of lined earthen aerated lagoons, secondary clarifiers, blowers, and waste and return sludge pumps. The clarifiers and pumps return solids to the lagoon allowing the process to maintain a higher concentration of mixed liquor suspended solids. The ammonia removal adds a significant oxygen requirement. Air is supplied to the single basin system through a fine bubble aeration system.

The aeration system includes blowers supplying compressed air to flexible aeration headers suspended across the basin. The air diffusers would be suspended onto the basin bottom from flexible down pipes. The aeration system would be fitted with blower timers for automatic on/off cycling, with blowers operated approximately 18 hours per day. This process approach results in measurable power savings. Additionally, the on/off cycling facilitates full denitrification, which releases alkalinity into the mixed liquor.

The earthen lagoons will be able to maintain a higher basin temperature than the elevated concrete basins at the existing facility. Therefore, the lagoons could be operated year-round uncovered. Freezing would be minimized due to the relatively high process temperature and the heat generated by the compressed air. The secondary clarifiers, blowers, waste pumps, and return

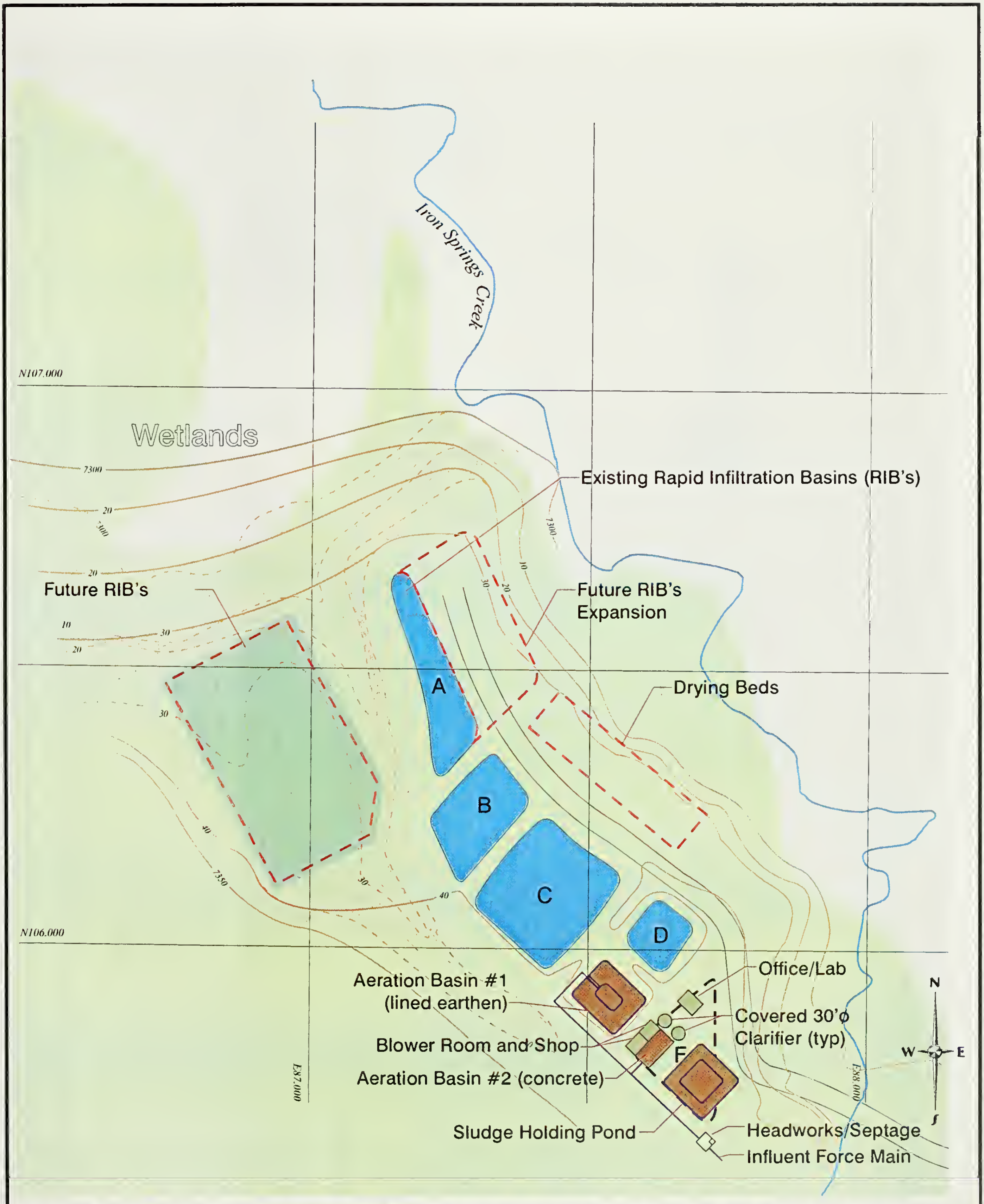

Figure 3-4 Old Faithful - Single Basin Facility Site Layout Rothberg, Tamburini & Winsor, Inc.

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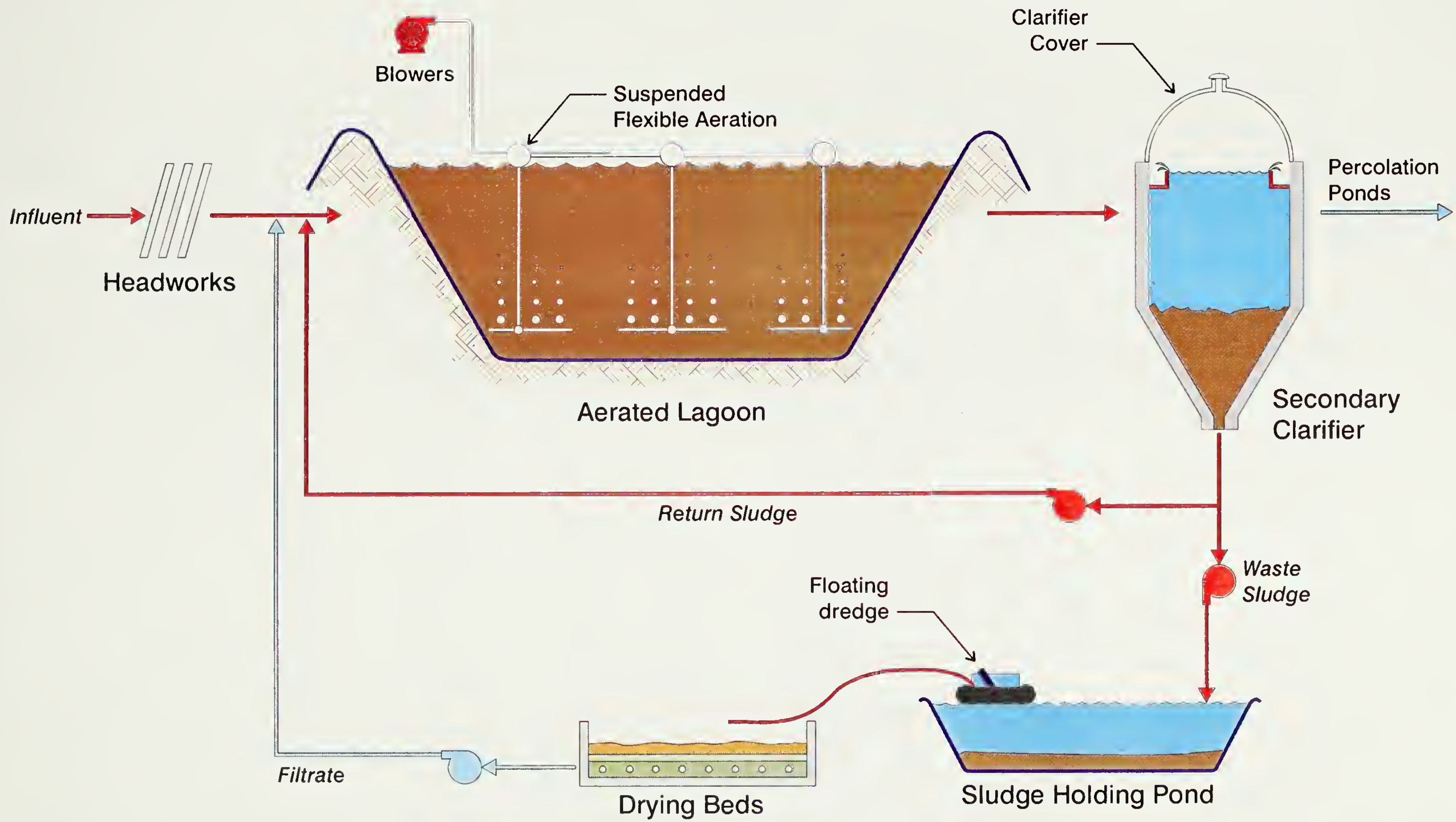

Figure 3-5 - Single Basin Flow Schematic

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pumps are recommended to be enclosed to prevent freezing for year-round operation.

Snow melt, with a typical pH of 6 to 6.5, will flow into the open basins during the spring run-off. This water will consume some alkalinity. The mixed liquor has alkalinity from the finished water that flows through the system and finally into the wastewater treatment plant. This alkalinity provides buffering capacity in the mixed liquor which helps maintain its pH level while absorbing the snow melt. Should the mixed liquor's alkalinity be lower than required during this short period of run-off, alkalinity can be added through addition of lime to the aerated lagoons.

The single basin is designed for a long solids retention time (sludge age), typically 40 days, to maintain a sufficient biomass of heterotrophs and the slower growing autotrophic nitrifying microorganisms *Nitrosomonas* and *Nitrobacter* for BOD, TSS, and nitrogen removal year-round in the open-air basin. Nutrient removal, including ammonia and nitrate, is accomplished by providing aerobic and anoxic zones within the aeration basin. Ammonia is converted to nitrate under aerobic conditions by autotrophic microorganisms. Heterotrophic microorganisms used to remove BOD under aerobic conditions convert nitrate to nitrogen gas under anoxic conditions. The effluent concentrations of ammonia and nitrate can be reduced to nearly zero with this process, as well as high treatment efficiency for BOD and TSS removal.

The BOD removal rate is affected by temperature; the rate decreases with decreasing process temperature. The mixed liquor suspended solids (MLSS) concentration is maintained at a relatively low and constant concentration between 1,500 to 2,000 mg/L. Therefore, to obtain the same substrate removal during cold periods, the hydraulic retention time is increased. The resulting design hydraulic detention time is 36 hours for maximum 30-day average flow, and 56 hours for annual average flow.

The treatment process is flexible to varying flows. Substantial fluctuations could be handled by dividing the total required aeration basin volume into two basins: a large basin for the visitor season flows and a small basin for the shoulder season.

Clarifiers are provided after the aeration basin to settle the mixed liquor from the treated effluent. A portion of the solids are returned to the aeration basin and the remaining solids are wasted from the treatment process to the biosolids storage lagoon. This sludge return process allows the system to separate the basin's hydraulic retention time from its solids retention time. Hindered settling and sludge compression are considered in the clarifier design. The clarifiers are designed with a side water depth of 12 to 15 ft,

surface overflow rate of 600 gpm/ft^2, and solids loading rate of less than 30 lb BOD/ft^2/day.

Advantages of single basins include the lowest capital cost, minimal pretreatment, reliable BOD, TSS and nitrogen removal under varying flow and temperature conditions, and conducive to construction phasing. The table below summarizes the advantages and disadvantages of the single basin process as compared with the other alternatives evaluated in this study.

Table 3-7 Advantages and Disadvantages of the Single Basin Process

Advantages	Disadvantages
Lowest capital cost	Higher daily process control
Minimal pretreatment required	Higher preventative maintenance
Reliable BOD, TSS, and nitrogen removal over varying flows	Aesthetic issues if basins are uncovered: visual and odor
Practical for construction phasing	Higher power consumption

For Old Faithful, the treatment process could be divided into one large and one small basin to accommodate varying flows: 765,000 gallons and 100,000 gallons respectively. Two clarifiers, 30 ft diameter each, would follow the aeration basins. The clarifiers would be piped to allow either to operate during the shoulder season, with both operating in parallel during the visitor season. Return activated sludge pumps (RAS) would be sized to provide firm pumping capacity at 1.5 times the maximum 30-day average flow. Waste sludge pumps would also be provided.

Biosolids would be handled as described for the RBC alternative. This process has an expected sludge yield of 0.7. With the same flows and BOD concentrations, the estimated sludge production is 3,000 gallons per day during the visitor season and 750 gallons per day during the off-season, or approximately 80 dry tons per year. WAS would be pumped into a partially mixed lagoon for biosolids treatment and storage. The Canyon Village AWT's floating dredger could be used to pump settled liquid biosolids, containing approximately 2 to 4% solids, to new air drying beds. The drying beds would be of similar size as the existing facility. Decant from the pond would be pumped back to the head of the plant. Biosolids would be pumped during the spring, summer and fall months to the air drying beds. The lagoon would store solids production during the winter months when sand bed drying would be less effective. Estimated required size of the biosolids lagoon for one-year storage volume, assuming the design conditions shown in Table 3-4, is 1.8 acre-feet (0.6 MG).

Single Basin Modification

The single basin process discussed in the previous section is the modification of the conventional aerated lagoon process with a secondary clarifier and sludge return pumps. A further modification of the single basin process is to operate the aerated lagoon as a batch process. Rather than capturing the solids leaving the aerated lagoon in the clarifier and returning solids to the head of the lagoon, batching allows the solids to settle in the lagoon. This alternative, therefore, eliminates the secondary clarifier and the return pump.

This process would be sized for 36 hour hydraulic detention time at maximum 30-day average flows ($Q_{max\ 30\text{-}day\ avg}$) and 56 hour hydraulic detention time at annual average flows ($Q_{ann\ avg}$). Mixed liquor concentrations would be maintained in the 1,500 mg MLSS/L to 2,000 mg MLSS/L range. The biomass is maintained at a constant mass through sludge wasting. The sludge would be retained in the aeration system for a calculated solids retention time (SRT or sludge age) of 40 days.

The batch process consists of three cycles: fill and aerate, sedimentation, and decant. Wastewater influent flows into one lagoon during fill and aerate cycle. At the end of this cycle, the aeration system is turned off and the solids allowed to settle. The settle time is approximately equal to the hydraulic detention time in a secondary clarifier sized for this flow. Once that lagoon goes into the sedimentation cycle, influent flow is diverted to the second basin.

As the dissolved oxygen concentration decreases during the sedimentation cycle, the anoxic conditions in the lagoon facilitate denitrification. At the end of the sedimentation cycle, the clarified effluent si decanted to the evaporation/percolation pond and the next cycle begins. Solids are produced as a function of BOD and ammonia removal. To maintain a constant biomass, solids are wasted from the aeration lagoon to the sludge holding lagoon during each decant cycle.

Septage Receiving and Pretreatment System

For each of the above alternatives, a septage receiving and pretreatment facility is included in the WWTP plant design. A concrete septage dump station suitable for handling septage haul trucks, is included. The dump station would be complete with containment walls to control splashing and to facilitate wash down and contain spills. The driving surface would be sloped to the drain location to facilitate full drainage of the tank trucks. Septage from the dump station would flow by gravity through a coarse bar screen into a septage holding tank. Odors would be controlled

through aeration and chlorine addition. A spray wash system is also incorporated in the design to break-up foam. A chopper pump would be utilized to grind sizable materials that pass through the bar screen and pump the septage sludge from the holding tank into the headworks building.

The septage holding tank is preliminarily sized at 6,500 gallons. This capacity will meet the immediate maximum daily septage loading rate and also provide some buffering for this flow and future growth. Providing a suitably sized holding tank allows the operators flexibility in feeding the septage to the plant over a reasonable time period, thereby minimizing shock loadings to the plant.

Septage waste contains approximately 10 times higher BOD and TSS concentrations, than influent wastewater, and may comprise a significant amount of the overall waste strength during periods of low flow. Therefore, the septage waste should be introduced at a low flow ratio to the influent wastewater stream. The aeration basin should be closely monitored, and adjustments made to the septage waste flow as necessary to ensure the effluent BOD and TSS are meeting the DEQ's discharge requirements.

Section Three Abbreviations

BOD_5	Biochemical oxygen demand
DEQ	Wyoming Department of Environmental Quality
gpd	Gallons per day
gpm	Gallons per minute
HP	Horsepower
lb/day	Pounds per day
MG	Million gallons
MGD	Million gallons per day
mg/L	Milligrams per liter
MLSS	Mixed liquor suspended solids
$Q_{max\ 30\text{-}d\ avg}$	Maximum 30-day average flow
Q_{peak}	Peak flow
PVC	Polyvinyl chloride
RAS	Return activated sludge pumps
RBC	Rotating biological contactor
SOR	Surface overflow rate
SRT	Solids retention time
TSS	Total suspended solids
WAS	Waste activated sludge
WWTP	Wastewater treatment plant

Treatment Alternative Selection

Selection Criteria

Criteria were developed to allow selection of the treatment alternative which would most closely meet the treatment objectives. Table 4-1 lists the selection criteria.

Table 4-1 Alternative Selection Criteria

Ranking	Criteria
1	Treatment Reliability
2	Capital Costs
3	Relative Annual Operating Costs
4	Operating Preferences

Four treatment alternatives were discussed in Section 3. One alternative considered was the expansion of the existing facility. The remaining three alternatives involved relocating the WWTP and included the rotating biological contactor process, the single basin nutrient removal process, and the single basin process modified to operate in a batch mode. The first three alternatives provide reliable treatment for BOD, TSS, ammonia, and nitrate removal. The fourth alternative is a modification of the single basin process to a sequencing batch process, and would be considered "innovative technology." Criteria addredded in this section is similar for both the single basin alternatives. Therefore, the modofied single basin alternative is not inlcuded as a separate treatment process in the following discussion.

A summary of each alternative's advantages and disadvantages is provided below in Table 4-2. Opinions of probable costs for the first three alternatives are provided at the end of this section as Tables 4-3, 4-4, and 4-5. The innovative technology alternative's initial capital cost was estimated as Table 4-5 minus the cost of the clarifiers and return sludge pumps, or approximately $500,000 less. However, if this process is selected, it is recommended that this amount plus an additional mobilization/demobilization be held in contingency for clarifier addition should they become necessary.

The recommended treatment approach is the single basin nutrient removal process. It is a reliable, proven process, and has the lowest capital cost and lowest present

worth cost when the operation and maintenance cost is estimated for a twenty year design life. This alternative is discussed in more detail in the following section.

Table 4-2 Comparison of Alternatives

Alternative:	Expansion of the Existing Facility at the Present Site	New Facility with a Rotating Biological Contactor Process	New Facility with a Single Basin Nutrient Removal Process
Advantages			
	Minimal pretreatment required	Lowest daily process control	Lowest capital cost
	Reliable BOD, TSS and nitrogen removal over varying flows	Lowest preventative maintenance	Minimal pretreatment required
		Reliable BOD, TSS and nitrogen removal over varying flows	Reliable BOD, TSS and nitrogen removal over varying flows
		Smaller footprint than Single Basin	Practical for construction phasing
		Practical for construction phasing	
		Lowest power consumption	
Disadvantages			
	Higher daily process control	Highest capital costs due to: Pretreatment Facility, Facility Enclosure, Higher cost/gal for RBC disks	Higher daily process control
	Aesthetic issues if uncovered: visual and odor		Higher preventative maintenance
	High cost	Greatest pretreatment requirements	Aesthetic issues if basins are uncovered: visual and odor
	Increased solids handling and odor control		Higher power consumption
	Higher power consumption		

Preferred Alternative — Single Basin Nutrient Removal Process

The single basin nutrient removal process provides BOD and TSS removal similar to a conventional aerated lagoon system, in addition to nitrification and denitrification for ammonia and nitrate removal. The specific process details were discussed in Section 3.

The estimate of probable cost for the single basin nutrient removal process is detailed in Table 4-5 and was estimated to be $5,794,720. The larger basin will be a geofrabic lined earthen basin. The smaller basin will be concrete. Process

worth cost when the operation and maintenance cost is estimated for a twenty year design life. This alternative is discussed in more detail in the following section.

Table 4-2 Comparison of Alternatives

Alternative:	Expansion of the Existing Facility at the Present Site	New Facility with a Rotating Biological Contactor Process	New Facility with a Single Basin Nutrient Removal Process
Advantages			
	Minimal pretreatment required	Lowest daily process control	Lowest capital cost
	Reliable BOD, TSS and nitrogen removal over varying flows	Lowest preventative maintenance	Minimal pretreatment required
		Reliable BOD, TSS and nitrogen removal over varying flows	Reliable BOD, TSS and nitrogen removal over varying flows
		Smaller footprint than Single Basin	Practical for construction phasing
		Practical for construction phasing	
		Lowest power consumption	
Disadvantages			
	Higher daily process control	Highest capital costs due to: Pretreatment Facility Facility Enclosure Higher cost/gal for RBC disks	Higher daily process control
	Aesthetic issues if uncovered: visual and odor		Higher preventative maintenance
	High cost	Greatest pretreatment requirements	Aesthetic issues if basins are uncovered: visual and odor
	Increased solids handling and odor control		Higher power consumption
	Higher power consumption		

Preferred Alternative — Single Basin Nutrient Removal Process

The single basin nutrient removal process provides BOD and TSS removal similar to a conventional aerated lagoon system, in addition to nitrification and denitrification for ammonia and nitrate removal. The specific process details were discussed in Section 3.

The estimate of probable cost for the single basin nutrient removal process is detailed in Table 4-5 and was estimated to be $5,794,720. The larger basin will be a geofrabic lined earthen basin. The smaller basin will be concrete. Process

equipment included blowers enclosed in a blower building, clarifiers, and pumps for return and waste sludge. Additional items include a lab/admin building, modification of two evaporation/percolation ponds to the aeration basins and sludge holding pond, sludge drying beds, and septage receiving facility. The existing effluent pump station would be converted to a raw wastewater pump station by replacing the pumps with non-clog centrifugal pumps. The existing chlorine contact chamber would be converted to emergency storage. A stand-by generator would be installed at the pump station and plant to provide back-up power. The sewer forcemain between the pump station and the new facility would be replaced. Pretreatment would include relocating the existing muffin monster at the influent pump station.

The relative annual operations and maintenance budget was estimated to be similar to the existing facility. Daily process control, weekly laboratory analysis, and equipment maintenance would be similar to a typical extended aeration activated sludge plant. Operation experience was taken into consideration in treatment alternative selection. Using a process similar to existing treatment facilities minimizes operator training required to bring a new facility on-line.

Estimate of Probable Cost

The following tables were developed to provide an estimate of probable cost for the treatment alternatives evaluated. These tables are presented in 1998 dollars. The contingency was estimated at 10% of the construction costs. NPS project supervision was estimated at 5% of the construction costs. Engineering design services were estimated at 10% of the construction cost. Construction phase services were estimated at 6% of the construction costs. Environmental Impact Study and permitting were outside the scope of this project, and estimates of probable cost for this work were not included.

Table 4-3 Expansion of Existing Facility - Opinion of Probable Construction Costs in 1998 Dollars

Item	Quantity	Unit	Unit Cost	Item Cost	Cost
Mob/Demob	1	ls	$150,000	$150,000	$150,000
Erosion Control	1	ls	$30,000	$30,000	$30,000
Dewatering	1	ls	$25,000	$25,000	$25,000
Treatment Plant Expansion					
Excavation and Backfill	10,000	cy	$7	$70,000	
Excavation and disposal on site	4,000	cy	$7	$28,000	
Site Work (grading, restoration and misc.)	1	ls	$200,000	$200,000	
Structural/granular fill	1,000	cy	$35	$35,000	
Aeration basin & Digester Concrete	3,000	cy	$450	$1,350,000	
Miscellaneous concrete	100	cy	$450	$45,000	
Aeration Equipment	1	ls	$250,000	$250,000	
Aeration Basin Cover	7,000	sq ft	$100	$700,000	
Clarifier	1	ea	$225,000	$225,000	
Aerobic Digester & Clarifier Covers	2	ea	$30,000	$60,000	
Mechanical plumbing and ventilation	1	ls	$50,000	$50,000	
RAS/WAS pumps	2	ea	$10,000	$20,000	
Miscellaneous metals	1	ls	$100,000	$100,000	
Mechanical process piping and valves	1	ls	$100,000	$100,000	
Yard Piping	500	lf	$50	$25,000	
Standby Generator	1	ea	$50,000	$50,000	
Electrical, instrumentation, controls	1	ls	$300,000	$300,000	
Electrical service upgrade	1	ls	$25,000	$25,000	
					$3,633,000
Septage Receiving Facility					
	1	ea	$200,000	$200,000	$200,000
Drying Bed Expansion & Air Drying Facility					
Drying Beds Retrofit with Deskins	10,500	sf	$25	$262,500	
Air Dry Equipment	1	ls	$40,000	$40,000	
Centrifuge Equipment	1	ea	$300,000	$300,000	
Centrifuge Building	1,000	sf	$150	$150,000	
					$752,500
Line Replacement: Lift Station to Perc Beds					
	2500	lf	$75	$187,500	$187,500
Subtotal					$4,978,000
Contingency (10%)					$497,800
NPS Project Supervision (5%)					$248,900
Engineering design (10%)					$497,800
Construction Phase Services (6%)					$298,680
Environmental Impact Study and Permitting				N/A	
TOTAL					$6,521,180

Table 4-4 Relocated Facility - RBCs - Opinion of Probable Construction Costs in 1998 Dollars

Item	Quantity	Unit	Unit Cost	Item Cost	Cost
Mob/Demob, Demo Existing Plant	1	ls	$200,000	$200,000	$200,000
Erosion Control	1	ls	$30,000	$30,000	$30,000
Dewatering	1	ls	$25,000	$25,000	$25,000
Modify Existing Fence	2690	lf	$5	$13,450	$13,450
New Fence	550	lf	$50	$27,500	$27,500
RBC Treatment Plant					
Excavation and Backfill	1,500	cy	$7	$10,500	
Excavation and disposal on site	1,600	cy	$7	$10,500	
Structural/granular fill	275	cy	$35	$9,625	
Crushed Stone Paving	1500	ton	$25	$30,000	
RBC basin concrete, misc. concrete	800	cy	$450	$360,000	
RBC units and Covers	15	ea	$100,500	$1,507,500	
Clarifier (30 ft diameter) & Cover	2	ea	$180,000	$360,000	
WAS pumps	3	ea	$10,000	$30,000	
Blowers	3	ea	$45,000	$135,000	
Mechanical process piping and valves	1	ls	$150,000	$150,000	
Mechanical plumbing and HVAC	1	ls	$50,000	$50,000	
Site Work (grading, site piping, restoration and misc.)	1	ls	$200,000	$200,000	
Miscellaneous metals	1	ls	$100,000	$100,000	
Administration/lab building	1,600	sq ft	$150	$240,000	
Standby Generator	1	ea	$80,000	$50,000	
Electrical, instrumentation, controls, service upgrade	1	ls	$590,000	$590,000	$3,773,125
Lift Station Conversion & Line Replacement					
Modification of Effluent Pump Station	1	ea	$80,000	$30,000	
Line Replacement: Lift station to Plant	2,700	lf	$75	$202,500	
Water Line Replacement	1,600	lf	$25	$45,000	$327,500
Septage Receiving Facility & Headworks					
Building/Tankage	1,600	sf	$150	$240,000	
Equipment	1	ea	$425,000	$425,000	$665,000
Drying Bed/Air Drying Facility					
Drying Beds	10,500	sf	$35	$367,500	
Sludge Turning Attachment (for existing Bobcat)	1	ea	$25,000	$25,000	
Polymer Feed Equipment	1	ea	$5,000	$5,000	$397,500
Sludge Lagoon					
Sludge Lagoon Decant Pump (use Canyon's Dredge)	1	ea	$25,000	$25,000	
Lagoon Liner	1	ea	$40,000	$40,000	$65,000
			Subtotal		$5,524,075
			Contingency (10%)		$552,408
			NPS Project Supervision (5%)		$276,204
			Engineering design (10%)		$552,408
			Construction Phase Services (6%)		$331,445
			Environmental Impact Study and Permitting	N/A	
			TOTAL		$7,236,538

Table 4-5 Relocated Facility—Single Basin —Opinion of Probable Construction Costs in 1998 Dollars

Item	Quantity	Unit	Unit Cost	Item Cost	Cost	
Mob/Demob	1	ls	$150,000	$150,000	$150,000	$150,000
Erosion Control	1	ls	$30,000	$30,000	$30,000	$150,000
Dewatering	1	ls	$25,000	$25,000	$25,000	$205,000
Modify Existing Fence	2690	lf	$5	$13,450	$13,450	$218,450
New Fence	550	lf	$50	$27,500	$27,500	$245,950
Lift Station Conversion & Line Replacement						
Modificationf Effluent Pump Station	1	ea	$30,000	$60,000		
Sewer Line Replacement:	2,700	lf	$50	$135,000		
Emergency storage	1	ea	$40,000	$40,000		
Stand-by Generator	1	ea	$30,000	$50,000		
Water Line Replacement	1,600	lf	$25	$40,000	$350,000	$595,950
Single Basin Treatment Plant						
Excavation and Backfill	20,000	cy	$5	$100,000		
Site Work (grading, restore, misc.)	1	ls	$200,000	$240,000		
Lagoon Liners	3	ea	$40,000	$120,000		
Crushed Stone Paving	1500	ton	$30	$45,000		
Concrete	1,000	cy	$450	$450,000		
Aeration Equipment	2	ea	$170,000	$340,000		
WAS/RAS pumps	6	ea	$10,000	$60,000		
Mechanical/Yard Piping and Valves	1	ea	$300,000	$340,000		
Clarifiers (30 ft diameter)	2	ea	$150,000	$340,000		
Clarifier covers	2	ea	$30,000	$50,000		
Miscellaneous metals	1	ls	$40,000	$40,000		
Mechanical plumbing and HVAC	1	ls	$50,000	$50,000		
* Administration/lab building	1,600	sq ft	$150	$240,000		
Emergency Generator	1	ea	$50,000	$50,000		
Electrical, instrumentation, controls	1	ls	$550,000	$550,000		
Electrical service upgrade	1	ls	$30,000	$30,000	$2,965,000	$3,560,950
Sludge Lagoon						
Lagoon Decant Pump	1	ea	$20,000	$20,000		
Lagoon Liner	1	ea	$40,000	$40,000		
Polymer Feed Equipment	1	ea	$5,000	$5,000	$70,000	$3,630,950
Septage Receiving & Headworks	1	ea	$200,000	$200,000	$200,000	$3,830,950
Drying Bed/Air Drying Facility						
Drying Beds	10,500	sf	$35	$367,500		
Sludge Turning Attachment	1	ea	$20,000	$20,000		
Polymer Feed Equipment	1	ea	$5,000	$5,000	$392,500	$4,223,450
Demo of Existing Plant	1	ea	$200,000	$200,000	$200,000	$4,423,450
Subtotal					$4,423,450	
Contingency (10%)					$442,345	
NPS Project Supervision (5%)					$221,173	
Engineering design (10%)					$442,345	
Construction Phase Services (6%)					$265,407	
Environmental Impact Study and Permitting				N/A		
TOTAL					$5,794,720	

Opinion of Probable Operating Costs

Manpower requirements were estimated for the project. For all treatment alternatives, it was assumed that labor personnel would include a supervisor and two operators. For each, the labor was estimated for a five-day week, 52 weeks per year. This labor cost includes operations time for daily process control and equipment maintenance. Contracted technical labor for major equipment overhauls, and major renewable maintenance supplies were included in the major maintenance category. Power costs were estimated at an electricity cost of $0.12/kW-hr.

The cost of the project over its twenty-year design life was calculated by bringing the annual operation and maintenance costs to a present worth at an interest rate of 10% by the following formula:

$$[Annual\ Cost]\ x\ \frac{(1+interest\ rate)^{(number\ of\ periods)}-1}{interest\ rate} = Present\ Worth$$

The adjusted annual cost is then added to the capital cost to obtain the overall cost. Table 4-6 lists the estimate of probable cost summary for the three alternatives. The single basin facility has the lowest capital cost and overall cost over the design life of the project.

Table 4-6 Estimate of Overall Costs

Alternative	Capital Cost	Annual Cost	Overall Cost
Single Basin Facility	$5,794,720	$204,961	$7,539,672
Existing Facility Expansion	$6,521,180	$222,945	$8,419,236
RBC Facility	$7,236,538	$201,232	$8,949,742

Table 4-7 through 4-9 lists estimates of annual operating costs for the three alternatives. The annual costs from these tables were brought into table 4-6 to calculate the overall cost of the alternatives.

Table 4-7 Annual Operating Cost Estimate for Single Basin Facility

Item	Time or Quantity	Unit Cost	Total Annual Cost
Labor - Supervisor	2 hr/day	$25/hr	$13,000
Labor - A Operator	8 hr/day	$21/hr	$43,680
Labor - B Operator	8 hr/day	$19/hr	$19,760
Major Maintenance - Pump Rebuild - Blower Rebuild - PLC Repair/Upgrade	1 unit	$50,000/yr	$50,000
Minor Maintenance - Lubricants - Minor Plumbing Repairs - Belts - Renewable Lab Supplies	1 unit	$20,000/yr	$20,000
Power	1 unit	$46,521/yr	$46,521
Biosolids Handling	12 units	$1,000	$12,000
Total			**$204,961**

Table 4-8 Annual Operating Cost Estimate for Existing Facility Expansion

Item	Time or Quantity	Unit Cost	Total Annual Cost
Labor - Supervisor	2 hr/day	$25/hr	$13,000
Labor - A Operator	8 hr/day	$21/hr	$43,680
Labor - B Operator	8 hr/day	$19/hr	$19,760
Major Maintenance - Pump Rebuild - Blower Rebuild - PLC Repair/Upgrade	1 unit	$50,000/yr	$50,000
Minor Maintenance - Lubricants - Minor Plumbing Repairs - Belts - Renewable Lab Supplies	1 unit	$20,000/yr	$20,000
Power	1 unit	$64,505/yr	$64,505
Biosolids Handling	12 units	$1,000	$12,000
Total			**$222,945**

Table 4-9 Annual Operating Cost Estimate for the RBC Facility

Item	Time or Quantity		Total Annual Cost
Labor - Supervisor	2 hr/day	$25/hr	$13,000
Labor - B Operator	8 hr/day	$21/hr	$43,680
Labor - B Operator	4 hr/day	$19/hr	$19,760
Major Maintenance - Pump Rebuild - Blower Rebuild -Micro Screen Rebuild - PLC Repair/Upgrade	1 unit	$50,000/yr	$50,000
Minor Maintenance - Lubricants - Minor Plumbing Repairs - Belts - Renewable Lab Supplies	1 unit	$20,000/yr	$20,000
Power	1 unit	$42,792/yr	$42,792
Biosolids Handling	12 units	$1,000	$12,000
Total			**$201,232**

Section Four Abbreviations

BOD	Biochemical oxygen demand
cy	Cubic yards
ea	Each
HVAC	Heating, ventilating and air conditioning
lf	Lineal feet
ls	Lump sum
RAS	Return activated sludge
RBC	Rotating biological contactor
SBR	Sequencing batch reactor
TSS	Total suspended solids
WAS	Waste activated sludge
WWTP	Wastewater treatment plant

Collection System

Background

The Old Faithful village and Government area are served by a sewer collection system which consists of gravity sewer lines and pumped lift stations. Portions of the collection system date back to the construction of the Old Faithful Inn. The lift stations have not been upgraded since the early 1970s.

The NPS maintenance staff has conducted a study of the collection system and has identified several lines which require immediate rehabilitation. The first, line "E," runs along the south side of Old Faithful geyser. The surrounding groundwater is hot. The resulting infiltration contains high concentrations of minerals which plate out on the pipe's interior as the water mixes with wastewater and cools. The line has had cracks and breaks which were temporarily repaired, but a long term solution is needed. The sections between manholes E-1 and E-3 have cracks and mineral deposits. The sections between E-3 and E-5 have a very flat grade and frequently back-up. The saturated soil and high groundwater would make line replacement difficult. Additionally, this line is located between the Lodge and the geyser along a path that fills with visitors everytime the geyser erupts. Construction in this area would be highly visible and would likely have a somewhat negative effect on some of the visitor's Old Faithful experience.

The line between the government trailer park and manhole A2 had a flat grade the caused back-ups in the trailer court. A lift station was recently installed near manhole A2 and the end of the line relaid to improve flow. The lift station works well, but adds to the annual operations time and cost.

Lift stations for both the Old Faithful Inn and the Old Faithful Lodge were constructed in the early 1970's and consist of pneumatic ejectors. Rehabilitation work would be required to bring the existing lift stations into compliance with current Wyoming Department of Environmental Quality (DEQ) regulations. Under these regulations, pneumatic ejectors are limited to design flows equivalent to 25 residential connections. The Inn and Lodge lift stations are sized for larger flows: 200 gpm and 150 gpm respectively. The regulations also require the lift station to have alternate power or 24 hours of storage. The existing stations have little storage volume and no backup power. The station's ejector would be required to be sized to have an ejector cycle of at least 10 minutes. The existing station's air compressors cycle constantly, resulting in limited equipment life. The mechanical

systems of the Inn and Lodge lift stations have been in operation beyond their design life and are wearing-out. Replacement parts are no longer available. Electrical energy consumption is high because these systems have extremely low efficiencies. In addition, the lift stations are extremely noisy. The excessive noise distracts from the surrounding natural setting and is a nuisance to visitors as public areas are located nearby.

Collection System Rehabilitation

Repair of the section of Line "E" adjacent to the geyser could be combined with the rehabilitation of the Lodge lift station. Preliminary investiagtion indicates the gravity flows through this section of line could be rerouted to the lift station with minimal piping changes. The lift station's discharge could be rerouted through a new line to the south of the Lodge to connect to the existing collection system in the Lodge's parking lot. Once these flows were rerouted, the section of Line "E" could be abandonded in place.

Modifications to the plant's influent piping could be combined with rerouting a section of the government trailer park line to eliminate the lift station at manhole A2. The lift station's wetwell could be abandonded in place, with the pumps and other equipment pulled for use in other locations of the maintenance system.

The lift stations for the Inn and Lodge could be rebuilt to include a wet well and dry-pit pump station. The stations would include alarms for power failure, high wet well level, etc, and standby power.

Table 5-1 lists estimate of probable cost for collection system rehabilitation.

Table 5-1 Collection System Rehabilitation — Estimate of Probable Cost

Item	Quantity	Unit	Unit Cost	Item Cost
Pipeline "E"	1,500	lf	$75	$112,500
Pipeline from trailer court to MH A2	1,500	lf	$75	$112,500
Pump Station Retrofit	2	ea	$100,000	$200,000
			Subtotal	$425,000
			Contingency (10%)	$42,500
			NPS Project Supervision (5%)	$21,250
			Engineering design (10%)	$42,500
			Construction Phase Services (6%)	$25,500
			TOTAL	**$556,750**

Section Five Abbreviations

DEQ	Department of Environmental Quality
ea	each
gpm	gallons per minute
lf	lineal feet
NPS	National Park Service

TW

APPENDIX A

FISCAL YEAR 94

UTILITIES REPORT

OLD FAITHFUL AREA

YELLOWSTONE NATIONAL PARK
WEST DISTRICT MAINTENANCE

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FY-94 SUMMARY

I. POTABLE WATER PRODUCTION
* Production Rate Average 480 GPM *

1. Total Water Produced:	61,915,961 gallons (100.00%)
2. Water used in Production:	6,102,000 gallons (9.86%)
3. Water Supplied to Distribution System:	55,813,961 gallons (90.14%)

II. TOTAL USAGE CONCESSIONS/NPS

1. All Concessions:	30,427,120 gallons (54.52%)
2. NPS:	25,386,841 gallons (45.48%)

III. WATER STATISTICS

1. Average Daily Usage:	152,915 gallons
2. High Month July 94:	10,332,930 gallons
3. Low Month November 93:	1,075,000 gallons

IV. WASTEWATER TREATMENT
* Effluent Pump Rate Average of 675 GPM *

1. Total Wastewater Flow: 44,578,350 gallons

2. Wastewater treated was 79.87% of water distributed.

V. WASTEWATER STATISTICS

1. Average Daily Flow:	122,133 gallons
2. High Month July 94:	8,403,750 gallons
3. Low Month March 94:	607,500 gallons
4. High Day July 07,1994:	332,100 gallons
5. Low Day March 28,1994:	12,150 gallons

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 94

WATER USAGE SUMMARY BY MONTH: OCT. 93 TO SEPT. 94

MONTH	WATER PRODUCED	WATER USED IN PROCESS	SUPPLIED TO SYSTEM
OCT 93	4,002,500	249,000	3,753,500
NOV 93	1,200,000	125,000	1,075,000
DEC 93	2,717,500	197,000	2,520,500
JAN 94	2,262,000	273,000	1,989,000
FEB 94	1,876,800	313,000	1,563,800
MAR 94	1,562,500	311,000	1,251,500
APR 94	2,561,160	731,000	1,830,160
MAY 94	6,808,138	1,470,000	5,338,138
JUN 94	9,626,263	800,000	8,826,263
JUL 94	10,922,930	590,000	10,332,930
AUG 94	10,252,470	568,000	9,684,470
SEP 94	8,123,700	475,000	7,648,700
TOTAL	61,915,961	6,102,000	55,813,961

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 94

USAGE BREAKDOWN

SITES/ LOCATIONS	TOTAL USAGE	PERCENTAGE WATER USAGE
TW	27,610,500	49.47%
NPS	25,386,841	45.48%
HAMILTON	2,161,600	3.87%
YPSS	524,000	.94%
MT POWER	82,600	.15%
WEST PARK	39,900	.07%
POST OFFICE	7,120	.01%
MT BELL	1,400	.01%
TOTAL	55,813,961	100.00%

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 94

WATER AND WASTEWATER COMPARISONS

MONTH	WATER SUPPLIED TO SYSTEM	WASTEWATER FLOW
OCT 93	3,753,500	2,899,800
NOV 93	1,075,000	741,150
DEC 93	2,520,500	1,296,000
JAN 94	1,989,000	1,652,400
FEB 94	1,563,800	1,518,750
MAR 94	1,251,500	607,500
APR 94	1,830,160	1,911,600
MAY 94	5,338,138	4,272,750
JUN 94	8,826,263	6,686,550
JUL 94	10,332,930	8,403,750
AUG 94	9,684,470	8,229,600
SEP 94	7,648,700	6,358,500
TOTAL	55,813,961	44,578,350

FISCAL YEAR 95

UTILITIES REPORT

OLD FAITHFUL AREA

YELLOWSTONE NATIONAL PARK
WEST DISTRICT MAINTENANCE

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FY-95 SUMMARY

I. POTABLE WATER PRODUCTION

1. Total Water Produced: 71,097,000 gallons (100.00%)

2. Water used in Backwash: 6,455,000 gallons (9.08%)

3. Water Supplied to Distribution System: 64,642,000 gallons (90.92%)

II. TOTAL USAGE CONCESSIONS/NPS

1. All Concessions: 36,861,900 gallons (57.03%)

2. NPS: 27,780,100 gallons (42.97%)

III. WATER STATISTICS

1. Average Daily Usage: 177,000 gallons

2. High Month July 95: 11,139,000 gallons

3. Low Month November 94: 1,307,000 gallons

IV. WASTEWATER TREATMENT
* Effluent Pump Rate Average of 560 GPM *

1. Total Wastewater Flow: 43,720,320 gallons

2. Wastewater treated was 67.64% of water distributed.

V. WASTEWATER STATISTICS

1. Average Daily Flow: 119,782 gallons

2. High Month July 95: 7,368,480 gallons

3. Low Month December 94: 776,160 gallons

4. High Day July 06,1995: 275,520 gallons

5. Low Day November 12, 1994: 13,440 gallons

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 95

WATER USAGE SUMMARY BY MONTH: OCT. 94 TO SEPT. 95

MONTH	WATER PRODUCED	WATER USED IN PROCESS	SUPPLIED TO SYSTEM
OCT 94	4,972,000	437,000	4,535,000
NOV 94	1,425,000	118,000	1,307,000
DEC 94	1,766,000	255,000	1,511,000
JAN 95	2,390,000	274,000	2,116,000
FEB 95	2,120,000	241,000	1,879,800
MAR 95	2,000,000	218,000	1,782,000
APR 95	4,007,000	432,000	3,575,000
MAY 95	10,020,000	1,491,000	8,529,000
JUN 95	10,334,000	1,726,000	8,608,000
JUL 95	11,702,000	563,000	11,139,000
AUG 95	10,688,000	374,000	10,688,000
SEP 95	9,299,000	326,000	8,973,000
TOTAL	71,097,000	6,455,000	64,642,000

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 95

USAGE BREAKDOWN

SITES/ LOCATIONS	TOTAL USAGE	PERCENTAGE WATER USAGE
TW	33,868,290	52.40%
NPS	27,780,100	42.97%
HAMILTON	2,226,250	3.44%
YPSS	482,490	.75%
MT POWER	211,890	.33%
WEST PARK	62,700	.09%
POST OFFICE	7,340	.01%
MT BELL	2,940	.01%
TOTAL	64,642,000	100.00%

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 95

WATER AND WASTEWATER COMPARISONS

MONTH	WATER SUPPLIED TO SYSTEM	WASTEWATER FLOW
OCT 94	4,535,000	2,852,640
NOV 94	1,307,000	1,189,440
DEC 94	1,511,000	776,160
JAN 95	2,116,000	1,354,080
FEB 95	1,879,000	1,290,240
MAR 95	1,782,000	1,307,040
APR 95	3,575,000	1,905,120
MAY 95	8,529,000	4,972,800
JUN 95	8,608,000	6,326,880
JUL 95	11,139,000	7,368,480
AUG 95	10,688,000	6,908,160
SEP 95	8,973,000	5,523,840
TOTAL	64,642,000	43,720,320

MEMORANDUM

DATE: 11-10-95

TO: JIM KNOELKE

FROM: ROD ROBEY

SUBJECT: WATER PRODUCTION AT OLD FAITHFUL WATER TREATMENT PLANT

MONTH/YR	WATER PRODUCED	BACKWASH WATER	TOTAL TO SYSTEM
OCTOBER/94	4,972,000 GAL	437,000 GAL (8.8%)	4,535,000 GAL
NOVEMBER/94	1,425,000 GAL	118,000 GAL (8.3%)	1,307,000 GAL
DECEMBER/94	1,766,000 GAL	255,000 GAL (14.4%)	1,511,000 GAL
JANUARY/95	2,390,000 GAL	274,000 GAL (11.5%)	2,116,000 GAL
FEBRUARY/95	2,120,000 GAL	241,000 GAL (11.4%)	1,879,000 GAL
MARCH/95	2,000,000 GAL	218,000 GAL (10.9%)	1,782,000 GAL
APRIL/95	4,007,000 GAL	432,000 GAL (10.8%)	3,575,000 GAL
MAY/95	10,020,000 GAL	1,491,000 GAL (14.9%)	8,529,000 GAL
JUNE/95	10,334,000 GAL	1,726,000 GAL (16.7%)	8,608,000 GAL
JULY/95	11,702,000 GAL	563,000 GAL (4.8%)	11,139,000 GAL
AUGUST/95	10,688,000 GAL	374,000 GAL (3.4%)	10,688,000 GAL
SEPTEMBER/95	9,299,000 GAL	326,000 GAL (3.5%)	8,973,000 GAL
TOTALS	71,097,000 GAL	6,455,000 GAL (9.1%)	64,642,000 GAL

HIGHLIGHTS

* HIGH DAY: 6/2/95, 580,000 GAL
* LOW DAY: 5/10/95, 21,000 GAL
* HIGH MONTH: JULY, 11,139,000 GAL
* LOW MONTH: NOVEMBER, 1,307,000 GAL
* PLANT RAN 268 OF 365 DAYS (97 DAYS NO PLANT OPERATION)
* AVERAGE DAILY USAGE: 177,000 GAL
* CONCESSIONS (METERED): 36,861,900 GAL

OLD FAITHFUL
WASTEWATER TREATMENT FLOWS
1995

EFFLUENT PUMP RATE AVERAGE OF 560 GPM *

MONTH	TOTAL HOURS PUMPS RAN	TOTAL GALLONS PER MONTH	AVERAGE GALLONS PER MONTH
October 1994	84.9	2,852,640	92,021
November 1994	35.4	1,189,440	39,648
December 1994	23.1	776,160 *	25,037
January 1995	40.3	1,354,080	43,680
February 1995	38.4	1,290,240	46,080
March 1995	38.9	1,307,040	42,163
April 1995	56.7	1,905,120	63,504
May 1995	148.0	4,972,800	160,413
June 1995	188.3	6,326,880	210,896
July 1995	219.3	7,368,480 *	237,693
August 1995	205.6	6,908,160	222,844
September 1995	164.4	5,523,840	184,128

TOTAL HOURS FOR YEAR = 1301.2 hours

TOTAL GALLONS FOR YEAR = 43,720,320 gals

AVERAGE GALLONS PER DAY = 119,782 gpd

HIGH MONTH = 7,368,480 gals, July 1995

LOW MONTH = 776,160 gals, December 1994

HIGH DAY = 275,520 gals, July 6, 1995

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FISCAL YEAR 96

UTILITIES REPORT

OLD FAITHFUL AREA

YELLOWSTONE NATIONAL PARK
WEST DISTRICT MAINTENANCE

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FY-96 SUMMARY

I. POTABLE WATER PRODUCTION
* Production Rate Average 543 GPM *

1. Total Water Produced:	77,514,000 gallons	(100.00%)
2. Water used in Production:	8,485,000 gallons	(10.95%)
3. Water Supplied to Distribution System:	69,029,000 gallons	(89.05%)

II. TOTAL USAGE CONCESSIONS/NPS

1. All Concessions:	37,668,570 gallons	(54.57%)
2. NPS:	31,360,430 gallons	(45.43%)

III. WATER STATISTICS

1. Average Daily Usage:		188,603 gallons
2. High Month	July 96:	11,396,000 gallons
3. Low Month	December 95:	1,601,000 gallons

IV. WASTEWATER TREATMENT
* Effluent Pump Rate Average of 650 GPM *

1. Total Wastewater Flow: 49,257,000 gallons

2. Wastewater treated was 71.36% of water distributed.

V. WASTEWATER STATISTICS

1. Average Daily Flow:		134,580 gallons
2. High Month	July 96:	8,041,800 gallons
3. Low Month	November 95:	1,201,200 gallons
4. High Day	July 25,1996:	285,624 gallons
	November 29 1995:	26,957 gallons

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 96

WATER USAGE SUMMARY BY MONTH: OCT. 95 TO SEPT. 96

MONTH	WATER PRODUCED	WATER USED IN PROCESS	SUPPLIED TO SYSTEM
OCT 95	6,176,000	311,000	5,865,000
NOV 95	1,843,000	164,000	1,679,000
DEC 95	1,825,000	224,000	1,601,000
JAN 96	2,443,000	252,000	2,191,000
FEB 96	2,226,000	175,000	2,051,000
MAR 96	1,915,000	150,000	1,765,000
APR 96	4,398,000	615,000	3,783,000
MAY 96	12,167,000	3,287,000	8,880,000
JUN 96	12,603,000	2,217,000	10,386,000
JUL 96	11,842,000	446,000	11,396,000
AUG 96	11,166,000	341,000	10,825,000
SEP 96	8,910,000	303,000	8,607,000
TOTAL	77,514,000	8,485,000	69,029,000

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 96

USAGE BREAKDOWN

SITES/ LOCATIONS	TOTAL USAGE	PERCENTAGE WATER USAGE
TW	34,513,420	50.00%
NPS	31,360,430	45.43%
HAMILTON	2,610,150	3.78%
YPSS	414,580	.60%
MT POWER	96,660	.14%
WEST PARK	24,100	.03%
POST OFFICE	7,990	.01%
MT BELL	1,670	.01%
TOTAL	69,029,000	100.00%

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 96

WATER AND WASTEWATER COMPARISONS

MONTH	WATER SUPPLIED TO SYSTEM	WASTEWATER FLOW
OCT 95	5,865,000	4,087,200
NOV 95	1,679,000	1,201,200
DEC 95	1,601,000	1,450,800
JAN 96	2,191,000	1,716,000
FEB 96	2,051,000	1,946,100
MAR 96	1,765,000	1,411,800
APR 96	3,783,000	2,347,800
MAY 96	8,880,000	6,376,500
JUN 96	10,386,000	7,468,500
JUL 96	11,396,000	8,041,800
AUG 96	10,825,000	7,476,300
SEP 96	8,607,000	5,733,000
TOTAL	69,029,000	49,257,000

OLD FAITHFUL
WASTEWATER TREATMENT FLOWS
FISCAL YEAR 1995

EFFLUENT PUMP RATE AVERAGE 650 GPM (EST)

MONTH	TOTAL HOURS PUMPS RAN	TOTAL GALLONS PER MONTH	AVERAGE GALLONS PER DAY
OCTOBER 1995	104.8	4,087,200	131,845
NOVEMBER 1995	30.8	1,201,200	40,040
DECEMBER 1995	37.2	1,450,800	46,800
JANUARY 1996	44.0	1,716,000	55,355
FEBRUARY 1996	49.9	1,946,100	67,107
MARCH 1996	36.2	1,411,800	45,541
APRIL 1996	60.2	2,347,800	78,260
MAY 1996	163.5	6,376,500	205,694
JUNE 1996	191.5	7,468,500	240,919
JULY 1996	206.2	8,041,800	259,413
AUGUST 1996	191.7	7,476,300	241,171
SEPTEMBER 1996	147.0	5,733,000	191,100

TOTAL ANNUAL FLOW - 49,257,000 gal

AVERAGE DAILY FLOW - 134,580 gal

HIGH MONTHLY FLOW - 8,041,800 gal; JULY 1996

LOW MONTHLY FLOW - 1,201,200 gal; NOVEMBER 1995

HIGH DAILY FLOW - 285,624 gal; JULY 25, 1996

LOW DAILY FLOW - 26,957 gal; NOVEMBER 29, 1995

TOTAL HOURS EFFLUENT PUMPS OPERATED - 1,263 hours

WATER PRODUCTION FOR FISCAL YEAR '94-'95

OLD FAITHFUL WATER TREATMENT PLANT

TH/YR	WATER PRODUCED	BACKWASH WATER	TOTAL TO SYSTEM
OBER/95	6,176,000 GAL	311,000 GAL (5.0%)	5,865,000 GAL
EMBER/95	1,843,000 GAL	164,000 GAL (8.9%)	1,679,000 GAL
EMBER/95	1,825,000 GAL	224,000 GAL (12.3%)	1,601,000 GAL
UARY/96	2,443,000 GAL	252,000 GAL (10.0%)	2,191,000 GAL
RUARY/96	2,226,000 GAL	175,000 GAL (7.9%)	2,051,000 GAL
CH/96	1,915,000 GAL	150,000 GAL (7.8%)	1,765,000 GAL
IL/96	4,398,000 GAL	615,000 GAL (14.0%)	3,783,000 GAL
/96	12,167,000 GAL	3,287,000 GAL (27.0%)	8,880,000 GAL
E/96	12,603,000 GAL	2,217,000 GAL (17.6%)	10,386,000 GAL
Y/96	11,842,000 GAL	446,000 GAL (3.8%)	11,396,000 GAL
UST/96	11,166,000 GAL	341,000 GAL (3.0%)	10,825,000 GAL
TEMBER/96	8,910,000 GAL	303,000 GAL (3.4%)	8,607,000 GAL
TALS	77,514,000 GAL	8,485,000 GAL (10.9%)	69,029,000 GAL

IGH DAY: 7/10/96 504,000 GAL
OW DAY: 11/29/95 14,000 GAL
IGH MONTH: JULY 11,396,000 GAL
OW MONTH: DECEMBER 1,601,000 GAL
PLANT RAN 282 DAYS OF 366 (84 DAYS NO PRODUCTION)
CONCESSIONS (METERED): 37,668,570 GAL

OLD FAITHFUL POTABLE WATER TO SYSTEM

1996	OCTOBER	5,721,000 GAL
	NOVEMBER	1,623,000
	DECEMBER	1,643,000
1997	JANUARY	2,181,000
	FEBRUARY	1,468,000
	MARCH	1,327,000
	APRIL	5,968,000
	MAY	9,053,000

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FISCAL YEAR 96

UTILITIES REPORT

OLD FAITHFUL AREA

YELLOWSTONE NATIONAL PARK
WEST DISTRICT MAINTENANCE

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FY-96 SUMMARY

I. POTABLE WATER PRODUCTION
* Production Rate Average 543 GPM *

1. Total Water Produced:	77,514,000 gallons	(100.00%)
2. Water used in Production:	8,485,000 gallons	(10.95%)
3. Water Supplied to Distribution System:	69,029,000 gallons	(89.05%)

II. TOTAL USAGE CONCESSIONS/NPS

1. All Concessions:	37,668,570 gallons	(54.57%)
2. NPS:	31,360,430 gallons	(45.43%)

III. WATER STATISTICS

1. Average Daily Usage:	188,603 gallons
2. High Month July 96:	11,396,000 gallons
3. Low Month December 95:	1,601,000 gallons

IV. WASTEWATER TREATMENT
* Effluent Pump Rate Average of 650 GPM *

1. Total Wastewater Flow: 49,257,000 gallons

2. Wastewater treated was 71.36% of water distributed.

V. WASTEWATER STATISTICS

1. Average Daily Flow:	134,580 gallons
2. High Month July 96:	8,041,800 gallons
3. Low Month November 95:	1,201,200 gallons
4. High Day July 25,1996:	285,624 gallons
5. Low Day November 29,1995:	26,957 gallons

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 96

WATER USAGE SUMMARY BY MONTH: OCT. 95 TO SEPT. 96

MONTH	WATER PRODUCED	WATER USED IN PROCESS	SUPPLIED TO SYSTEM
OCT 95	6,176,000	311,000	5,865,000
NOV 95	1,843,000	164,000	1,679,000
DEC 95	1,825,000	224,000	1,601,000
JAN 96	2,443,000	252,000	2,191,000
FEB 96	2,226,000	175,000	2,051,000
MAR 96	1,915,000	150,000	1,765,000
APR 96	4,398,000	615,000	3,783,000
MAY 96	12,167,000	3,287,000	8,880,000
JUN 96	12,603,000	2,217,000	10,386,000
JUL 96	11,842,000	446,000	11,396,000
AUG 96	11,166,000	341,000	10,825,000
SEP 96	8,910,000	303,000	8,607,000
TOTAL	77,514,000	8,485,000	69,029,000

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 96

USAGE BREAKDOWN

SITES/ LOCATIONS	TOTAL USAGE	PERCENTAGE WATER USAGE
TW	34,513,420	50.00%
NPS	31,360,430	45.43%
HAMILTON	2,610,150	3.78%
YPSS	414,580	.60%
MT POWER	96,660	.14%
WEST PARK	24,100	.03%
POST OFFICE	7,990	.01%
MT BELL	1,670	.01%
TOTAL	69,029,000	100.00%

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 96

WATER AND WASTEWATER COMPARISONS

MONTH	WATER SUPPLIED TO SYSTEM	WASTEWATER FLOW
OCT 95	5,865,000	4,087,200
NOV 95	1,679,000	1,201,200
DEC 95	1,601,000	1,450,800
JAN 96	2,191,000	1,716,000
FEB 96	2,051,000	1,946,100
MAR 96	1,765,000	1,411,800
APR 96	3,783,000	2,347,800
MAY 96	8,880,000	6,376,500
JUN 96	10,386,000	7,468,500
JUL 96	11,396,000	8,041,800
AUG 96	10,825,000	7,476,300
SEP 96	8,607,000	5,733,000
TOTAL	69,029,000	49,257,000

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OLD FAITHFUL
WASTEWATER TREATMENT FLOWS
1995

EFFLUENT PUMP RATE AVERAGE OF 560 GPM *

MONTH	TOTAL HOURS PUMPS RAN	TOTAL GALLONS PER MONTH	AVERAGE GALLONS PER MONTH
October 1994	84.9	2,852,640	92,021
November 1994	35.4	1,189,440	39,648
December 1994	23.1	776,160 *	25,037
January 1995	40.3	1,354,080	43,680
February 1995	38.4	1,290,240	46,080
March 1995	38.9	1,307,040	42,163
April 1995	56.7	1,905,120	63,504
May 1995	148.0	4,972,800	160,413
June 1995	188.3	6,326,880	210,896
July 1995	219.3	7,368,480 *	237,693
August 1995	205.6	6,908,160	222,844
September 1995	164.4	5,523,840	184,128

TOTAL HOURS FOR YEAR = 1301.2 hours

TOTAL GALLONS FOR YEAR = 43,720,320 gals

AVERAGE GALLONS PER DAY = 119,782 gpd

HIGH MONTH = 7,368,480 gals, July 1995

LOW MONTH = 776,160 gals, December 1994

HIGH DAY = 275,520 gals, July 6, 1995

LOW DAY = 13,440 gals, November 12, 1994

OLD FAITHFUL
WASTEWATER TREATMENT FLOWS
FISCAL YEAR 1995

EFFLUENT PUMP RATE AVERAGE 650 GPM (EST)

MONTH	TOTAL HOURS PUMPS RAN	TOTAL GALLONS PER MONTH	AVERAGE GALLONS PER DAY
OCTOBER 1995	104.8	4,087,200	131,845
NOVEMBER 1995	30.8	1,201,200	40,040
DECEMBER 1995	37.2	1,450,800	46,800
JANUARY 1996	44.0	1,716,000	55,355
FEBRUARY 1996	49.9	1,946,100	67,107
MARCH 1996	36.2	1,411,800	45,541
APRIL 1996	60.2	2,347,800	78,260
MAY 1996	163.5	6,376,500	205,694
JUNE 1996	191.5	7,468,500	240,919
JULY 1996	206.2	8,041,800	259,413
AUGUST 1996	191.7	7,476,300	241,171
SEPTEMBER 1996	147.0	5,733,000	191,100

TOTAL ANNUAL FLOW - 49,257,000 gal

AVERAGE DAILY FLOW - 134,580 gal

HIGH MONTHLY FLOW - 8,041,800 gal; JULY 1996

LOW MONTHLY FLOW - 1,201,200 gal; NOVEMBER 1995

HIGH DAILY FLOW - 285,624 gal; JULY 25, 1996

LOW DAILY FLOW - 26,957 gal; NOVEMBER 29, 1995

TOTAL HOURS EFFLUENT PUMPS OPERATED - 1,263 hours

WATER PRODUCTION FOR FISCAL YEAR '94-'95

OLD FAITHFUL WATER TREATMENT PLANT

NTH/YR	WATER PRODUCED	BACKWASH WATER	TOTAL TO SYSTEM
TOBER/95	6,176,000 GAL	311,000 GAL (5.0%)	5,865,000 GAL
VEMBER/95	1,843,000 GAL	164,000 GAL (8.9%)	1,679,000 GAL
ECEMBER/95	1,825,000 GAL	224,000 GAL (12.3%)	1,601,000 GAL
ANUARY/96	2,443,000 GAL	252,000 GAL (10.0%)	2,191,000 GAL
EBRUARY/96	2,226,000 GAL	175,000 GAL (7.9%)	2,051,000 GAL
ARCH/96	1,915,000 GAL	150,000 GAL (7.8%)	1,765,000 GAL
PRIL/96	4,398,000 GAL	615,000 GAL (14.0%)	3,783,000 GAL
AY/96	12,167,000 GAL	3,287,000 GAL (27.0%)	8,880,000 GAL
UNE/96	12,603,000 GAL	2,217,000 GAL (17.6%)	10,386,000 GAL
ULY/96	11,842,000 GAL	446,000 GAL (3.8%)	11,396,000 GAL
UGUST/96	11,166,000 GAL	341,000 GAL (3.0%)	10,825,000 GAL
EPTEMBER/96	8,910,000 GAL	303,000 GAL (3.4%)	8,607,000 GAL
OTALS	77,514,000 GAL	8,485,000 GAL (10.9%)	69,029,000 GAL

* HIGH DAY: 7/10/96 504,000 GAL
* LOW DAY: 11/29/95 14,000 GAL
* HIGH MONTH: JULY 11,396,000 GAL
* LOW MONTH: DECEMBER 1,601,000 GAL
* PLANT RAN 282 DAYS OF 366 (84 DAYS NO PRODUCTION)
* CONCESSIONS (METERED): 37,668,570 GAL

WASTEWATER

1. Total Flow 49,25~~8~~,000

2. Average Pump Rate or Flow RATE GPM
650 GPM

3. Average Daily flow 134,580 gal/da

Tim Hudson

FISCAL YEAR 97

UTILITIES REPORT

OLD FAITHFUL AREA

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL MAINTENANCE DISTRICT

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FY-97 SUMMARY

I. POTABLE WATER PRODUCTION
* Production Rate Average 542.5 GPM *

1. Total Water Produced:	80,224,000 gallons	(100.00%)
2. Water used in Production:	6,974,000 gallons	(8.70%)
3. Water Supplied to Distribution System:	73,250,000 gallons	(91.30%)

II. TOTAL USAGE CONCESSIONS/NPS

1. All Concessions:	44,338,220 gallons	(60.53%)
2. NPS:	28,911,780 gallons	(39.47%)

III. WATER STATISTICS

1. Average Daily Usage:		200,685 gallons
2. High Month	July 97:	12,017,000 gallons
3. Low Month	March 97:	1,327,000 gallons

IV. WASTEWATER TREATMENT
* Effluent Pump Rate Average of 620 GPM *

1. Total Wastewater Flow: 51,004,890 gallons

2. Wastewater treated was 69.64% of water distributed.

V. WASTEWATER STATISTICS

1. Average Daily Flow:		139,739 gallons
2. High Month	July 97:	8,900,864 gallons
3. Low Month	March 97:	993,240 gallons
4. High Day	July 29,1997:	317,333 gallons
5. Low Day	March 29,1997:	15,471 gallons

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 97

WATER USAGE SUMMARY BY MONTH: OCT. 96 TO SEPT. 97

MONTH		WATER PRODUCED		WATER USED IN PROCESS	SUPPLIED TO SYSTEM
OCT 96	31	5,915,000	0.191	237,000	5,678,000
NOV 96	30	1,760,000	0.059	137,000	1,623,000
DEC 96	31	1,798,000	0.058	155,000	1,643,000
JAN 97	31	2,260,000	0.073	179,000	2,081,000
FEB 97	28	1,662,000	0.059	194,000	1,468,000
MAR 97	31	1,440,000	0.046	113,000	1,327,000
APR 97	30	6,731,000	0.224	859,000	5,872,000
MAY 97	31	11,200,000	0.361	2,206,000	8,994,000
JUN 97	30	13,233,000	0.441	1,373,000	11,860,000
JUL 97	31	12,538,000	0.404	521,000	12,017,000
AUG 97	31	12,188,000	0.393	536,000	11,652,000
SEP 97	30	9,499,000	0.317	464,000	9,035,000
TOTAL		80,224,000		6,974,000	73,250,000

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 97

USAGE BREAKDOWN

SITES/ LOCATIONS	TOTAL USAGE	PERCENTAGE WATER USAGE
AMFAC	41,105,470	56.11%
NPS	28,911,780	39.47%
HAMILTON	2,468,340	3.37%
YPSS	671,480	.92%
MT POWER	70,920	.10%
POST OFFICE	13,020	.01%
WEST PARK	8,010	.01%
MT BELL	980	.01%
TOTAL	73,250,000	100.00%

YELLOWSTONE NATIONAL PARK
OLD FAITHFUL UTILITY DISTRICT

FISCAL YEAR 97

WATER AND WASTEWATER COMPARISONS

MONTH	WATER SUPPLIED TO SYSTEM	WASTEWATER FLOW	
OCT 96	5,678,000	3,314,520*	.584
NOV 96	1,623,000	1,089,960*	.67
DEC 96	1,643,000	1,432,200*	.87
JAN 97	2,081,000	1,517,760*	.73
FEB 97	1,468,000	1,294,560*	.88
MAR 97	1,327,000	993,240*	.75
APR 97	5,872,000	2,618,880*	.45
MAY 97	8,994,000	6,614,160*	.74
JUN 97	11,860,000	8,189,868**	.69
JUL 97	12,017,000	8,900,364**	.74
AUG 97	11,652,000	8,556,564**	.73
SEP 97	9,035,000	6,482,814**	.72
TOTAL	73,250,000	51,004,890	

Wastewater flows based on the following:
* Flows based on effluent pump average of: 620 GPM.
** Flows based on influent pump averages of: 492 GPM (pump #1)
545 GPM (pump #3)

.300 → .8

RTW

APPENDIX B

CUMULATIVE DATA
AND DESCRIPTIVE STATISTICS REPORT
(1972 - 1995 Inclusive)
FOR
GROUND AND SURFACE WATER MONITORING
NEAR PERCOLATION PONDS

MAINTENANCE DIVISION
MAMMOTH HOT SPRINGS
YELLOWSTONE NATIONAL PARK, WY

Prepared by:

MALICOAT, BECKS & ASSOCIATES, INC.
P.O. BOX 348
Martinez, CA 94553
(510) 228-9477
Becks, M.P.H.

December, 1995

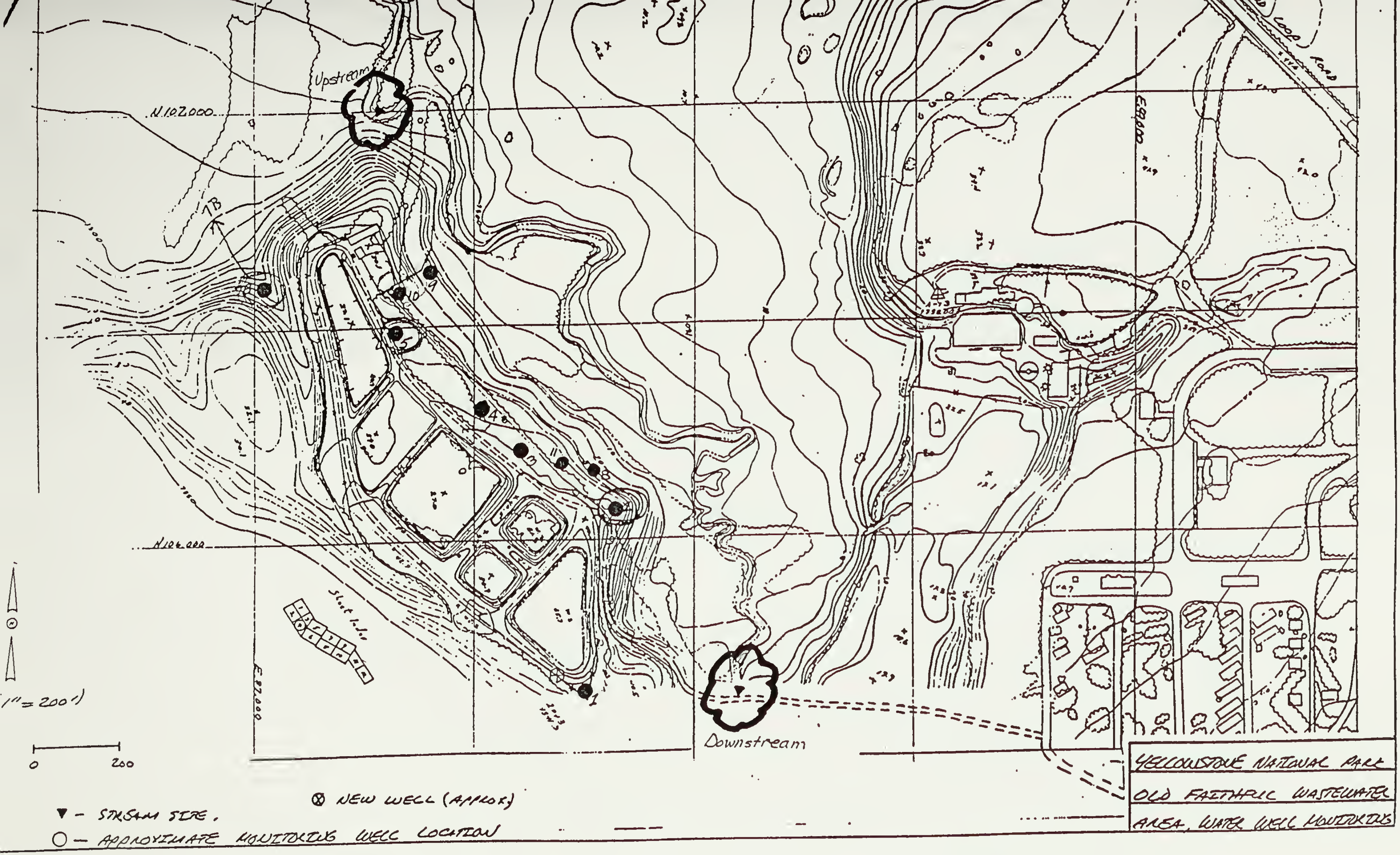

FIGURE 3c

OLD FAITHFUL

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COMMAND: LIST MISSING VALUE TREATMENT: INCLUDE

VARIABLES: Conductivity (m-µ/c)

CASE	YEAR	SC	CL	NO3	KJLDN	WT_ELEV
1	88.0000	98.0000	4.90000	0.250000	2.20000	7334.70
2	74.0000	105.000	2.30000	0.0300000	0.110000	--
3	82.0000	110.000	3.10000	0.0500000	--	--
4	83.0000	110.000	3.00000	0.120000	--	--
5	74.0000	110.000	3.00000	0.110000	--	7335.00
6	85.0000	105.000	2.80000	0.0500000	--	7335.00
7	87.0000	110.000	4.20000	0.0900000	--	7334.90
8	89.0000	111.000	3.00000	0.0500000	0.600000	7334.90
9	90.0000	101.000	2.00000	0.0700000	0.300000	7334.90
10	91.0000	110.000	2.00000	0.0500000	0.100000	7334.91
11	92.0000	96.4000	7.00000	0.0600000	0.200000	7334.96
12	93.0000	105.000	1.90000	0.100000	0.100000	7334.60
13	94.0000	141.000	3.00000	0.0500000	0.100000	7334.69
14	95.0000	92.0000	3.00000	0.0600000	0.100000	7334.74

COMMAND: DESC MISSING VALUE TREATMENT: VARWISE

*** DESCRIPTIVE STATISTICS ***

THERE ARE 6 VARIABLES AND 14 CASES IN THE DATA SET

VARIABLE	VALID CASES	NUMBER MISSING	% MISSING
SC	14	0	0.0
CL	14	0	0.0
NO3	14	0	0.0
KJLDN	9	5	35.7
WT_ELEV	11	3	21.4

VARIABLE	MEAN	STD.DEV.	VARIANCE	STD ERROR OF MEAN	COEFF OF VARIATION
SC	107.457	11.3694	129.264	3.03861	10.5804
CL	3.22857	1.36067	1.85143	0.363655	42.1447
NO3	0.0814286	0.0553113	0.00305934	0.0147826	67.9262
KJLDN	0.423333	0.686404	0.471150	0.228801	162.143
WT_ELEV	7334.85	0.138084	0.0190673	0.0416340	0.00188258

VARIABLE	MINIMUM	MAXIMUM	RANGE	TOTAL
SC	92.0000	141.000	49.0000	1504.40
CL	1.90000	7.00000	5.10000	45.2000
NO3	0.0300000	0.250000	0.220000	1.14000
KJLDN	0.100000	2.20000	2.10000	3.81000
WT_ELEV	7334.60	7335.00	0.400000	80683.3

file B:OF02.AB8 version:14

COMMAND: LIST   MISSING VALUE TREATMENT: INCLUDE

VARIABLES:

CASE	YEAR	SC	CL	NO3	KJLDN	WT_ELEV
1	88	388.000	26.0000	9.20000	10.0000	7306.40
2	74	180.000	5.80000	8.50000	--	--
3	76	285.000	36.0000	0.280000	6.80000	--
4	77	175.000	12.0000	--	3.20000	--
5	78	440.000	45.0000	0.420000	3.90000	--
6	79	300.000	17.0000	7.80000	5.00000	--
7	80	415.000	34.0000	0.180000	4.20000	--
8	82	465.000	40.0000	0.0500000	--	--
9	83	300.000	39.0000	4.00000	--	--
10	84	265.000	35.0000	9.00000	--	7310.00
11	85	390.000	43.0000	0.320000	--	7310.00
12	87	330.000	46.0000	2.80000	--	7308.40
13	89	249.000	28.0000	1.40000	3.70000	7308.80
14	90	378.000	29.0000	3.60000	11.0000	7307.10
15	91	402.000	42.0000	0.200000	16.7000	7309.26
16	92	334.000	41.0000	1.00000	1.60000	7308.56
17	93	335.000	31.9000	2.16000	11.5000	7310.10
18	94	311.000	41.0000	2.33000	0.100000	7308.03
19	95	364.000	38.0000	0.790000	10.4000	7309.37

COMMAND: DESC   MISSING VALUE TREATMENT: VARWISE

*** DESCRIPTIVE STATISTICS ***

THERE ARE 6 VARIABLES AND 19 CASES IN THE DATA SET

VARIABLE	VALID CASES	NUMBER MISSING	% MISSING
SC	19	0	0.0
CL	19	0	0.0
NO3	18	1	5.3
KJLDN	13	6	31.6
WT_ELEV	11	8	42.1

VARIABLE	MEAN	STD.DEV.	VARIANCE	STD ERROR OF MEAN	COEFF OF VARIATION
SC	331.895	79.8011	6368.21	18.3076	24.0441
CL	33.1421	11.2390	126.315	2.57840	33.9115
NO3	3.00167	3.32071	11.0271	0.782698	110.629
KJLDN	6.77692	4.77706	22.8203	1.32492	70.4900
WT_ELEV	7308.73	1.20464	1.45117	0.363214	0.0164823

VARIABLE	MINIMUM	MAXIMUM	RANGE	TOTAL
SC	175.000	465.000	290.000	6306.00
CL	5.80000	46.0000	40.2000	629.700
NO3	0.0500000	9.20000	9.15000	54.0300
KJLDN	0.100000	16.7000	16.6000	88.1000
WT_ELEV	7306.40	7310.10	3.70000	80396.0

file B:OF03.AB8 version:9

COMMAND: LIST MISSING VALUE TREATMENT: INCLUDE

VARIABLES:

CASE	YEAR	SC	CL	NO3	KJLDN	WT_ELEV
1	88.0000	512.000	39.0000	0.650000	28.0000	7306.40
2	74.0000	290.000	21.0000	0.610000	10.0000	--
3	75.0000	215.000	21.0000	0.0400000	--	--
4	76.0000	350.000	37.0000	6.60000	6.50000	--
5	77.0000	435.000	47.0000	0.00000	13.0000	--
6	78.0000	360.000	42.0000	4.00000	2.90000	--
7	79.0000	370.000	40.0000	4.60000	11.0000	--
8	80.0000	390.000	40.0000	3.40000	5.00000	--
9	82.0000	360.000	34.0000	2.60000	--	--
10	83.0000	470.000	42.0000	4.70000	--	--
11	84.0000	240.000	27.0000	1.30000	--	7309.00
12	85.0000	360.000	38.0000	8.60000	--	7309.00
13	87.0000	280.000	41.0000	4.90000	--	7307.50
14	89.0000	317.000	30.0000	1.00000	11.0000	7309.30
15	90.0000	293.000	9.50000	0.850000	9.40000	7307.30
16	91.0000	466.000	42.0000	0.990000	19.5000	7308.15
17	92.0000	469.000	38.0000	6.23000	10.0000	7307.70
18	93.0000	245.000	32.6000	2.42000	3.50000	7309.50
19	94.0000	412.000	42.0000	6.16000	25.3000	7308.05

COMMAND: DESC MISSING VALUE TREATMENT: VARWISE

*** DESCRIPTIVE STATISTICS ***

THERE ARE 6 VARIABLES AND 19 CASES IN THE DATA SET

VARIABLE	VALID CASES	NUMBER MISSING	% MISSING
SC	19	0	0.0
CL	19	0	0.0
NO3	19	0	0.0
KJLDN	13	6	31.6
WT_ELEV	10	9	47.4

VARIABLE	MEAN	STD.DEV.	VARIANCE	STD ERROR OF MEAN	COEFF OF VARIATION
SC	359.684	86.2928	7446.45	19.7969	23.9913
CL	34.9000	9.43345	88.9900	2.16418	27.0299
NO3	3.13947	2.57805	6.64634	0.591445	82.1172
KJLDN	11.9308	7.85890	61.7623	2.17967	65.8709
WT_ELEV	7308.19	0.999667	0.999333	0.316122	0.0136787

VARIABLE	MINIMUM	MAXIMUM	RANGE	TOTAL
SC	215.000	512.000	297.000	6834.00
CL	9.50000	47.0000	37.5000	663.100
NO3	0.00000	8.60000	8.60000	59.6500
KJLDN	2.90000	28.0000	25.1000	155.100
WT_ELEV	7306.40	7309.50	3.10000	73081.9

file B OF04 AB8 version:11

COMMAND: LIST   MISSING VALUE TREATMENT: INCLUDE

VARIABLES:

CASE	YEAR	SC	CL	NO3	KJLDN	WT_ELEV
1	88.0000	471.000	40.0000	0.580000	14.0000	7303.70
2	74.0000	400.000	21.0000	0.130000	20.0000	--
3	77.0000	415.000	50.0000	--	12.0000	--
4	78.0000	370.000	48.0000	0.300000	6.30000	--
5	79.0000	435.000	40.0000	3.30000	11.0000	--
6	80.0000	415.000	41.0000	0.700000	5.00000	--
7	82.0000	545.000	36.0000	0.0500000	--	--
8	83.0000	420.000	36.0000	2.30000	--	--
9	84.0000	320.000	36.0000	0.430000	--	7306.00
10	85.0000	375.000	43.0000	0.710000	--	7306.00
11	87.0000	360.000	44.0000	1.40000	--	7304.90
12	89.0000	384.000	30.0000	0.130000	13.0000	7307.00
13	90.0000	332.000	32.0000	1.60000	15.0000	7306.00
14	91.0000	384.000	41.0000	1.68000	7.60000	7307.09
15	92.0000	331.000	39.0000	5.26000	2.80000	7305.93
16	93.0000	242.000	33.2000	2.79000	3.30000	7306.40
17	94.0000	207.000	18.0000	5.28000	3.20000	7306.46
18	95.0000	205.000	40.0000	1.11000	1.00000	7306.91

COMMAND: DESC   MISSING VALUE TREATMENT: VARWISE

*** DESCRIPTIVE STATISTICS ***

THERE ARE 6 VARIABLES AND 18 CASES IN THE DATA SET

VARIABLE	VALID CASES	NUMBER MISSING	% MISSING
SC	18	0	0.0
CL	18	0	0.0
NO3	17	1	5.6
KJLDN	13	5	27.8
WT_ELEV	11	7	38.9

VARIABLE	MEAN	STD.DEV.	VARIANCE	STD ERROR OF MEAN	COEFF OF VARIATION
SC	367.278	86.9508	7560.45	20.4945	23.6744
CL	37.1222	8.21108	67.4218	1.93537	22.1190
NO3	1.63235	1.66637	2.77678	0.404154	102.084
KJLDN	8.78462	5.80386	33.6847	1.60970	66.0684
WT_ELEV	7306.04	0.993925	0.987887	0.299680	0.0136042

VARIABLE	MINIMUM	MAXIMUM	RANGE	TOTAL
SC	205.000	545.000	340.000	6611.00
CL	18.0000	50.0000	32.0000	668.200
NO3	0.0500000	5.28000	5.23000	27.7500
KJLDN	1.00000	20.0000	19.0000	114.200
WT_ELEV	7303.70	7307.09	3.39000	80366.4

file B:OF05.AB8 version:11

COMMAND: LIST MISSING VALUE TREATMENT: INCLUDE

VARIABLES:

CASE	YEAR	SC	CL	NO3	KJLDN	WT_ELEV
1	88.0000	356.000	35.0000	2.80000	11.0000	7301.10
2	74.0000	250.000	27.0000	0.230000	--	--
3	75.0000	505.000	7.50000	40.0000	--	--
4	76.0000	475.000	34.0000	0.110000	5.60000	--
5	77.0000	330.000	49.0000	--	4.20000	--
6	78.0000	280.000	39.0000	4.90000	5.80000	--
7	79.0000	255.000	38.0000	4.00000	3.40000	--
8	80.0000	215.000	36.0000	3.60000	1.80000	--
9	82.0000	430.000	30.0000	13.0000	--	--
10	83.0000	300.000	37.0000	12.0000	--	--
11	84.0000	260.000	31.0000	13.0000	--	7303.00
12	85.0000	300.000	38.0000	7.20000	--	7303.00
13	87.0000	340.000	48.0000	1.00000	--	7302.40
14	89.0000	227.000	29.0000	4.50000	3.60000	7302.80
15	90.0000	242.000	35.0000	3.30000	4.80000	7303.20
16	91.0000	337.000	33.0000	14.8000	4.90000	7302.93
17	92.0000	417.000	39.0000	13.4000	4.10000	7302.90
18	93.0000	398.000	28.1000	41.8000	3.70000	7302.80
19	94.0000	207.000	46.0000	7.47000	2.20000	7302.86
20	95.0000	294.000	28.0000	14.6000	1.00000	7302.91

COMMAND: DESC MISSING VALUE TREATMENT: VARWISE

*** DESCRIPTIVE STATISTICS ***

THERE ARE 6 VARIABLES AND 20 CASES IN THE DATA SET

VARIABLE	VALID CASES	NUMBER MISSING	% MISSING
SC	20	0	0.0
CL	20	0	0.0
NO3	19	1	5.0
KJLDN	13	7	35.0
WT_ELEV	11	9	45.0

VARIABLE	MEAN	STD.DEV.	VARIANCE	STD ERROR OF MEAN	COEFF OF VARIATION
SC	320.900	86.5234	7486.31	19.3472	26.9627
CL	34.3800	8.98001	80.6406	2.00799	26.1199
NO3	10.6163	11.7857	138.902	2.70382	111.015
KJLDN	4.31538	2.46132	6.05808	0.682646	57.0358
WT_ELEV	7302.72	0.570873	0.325896	0.172125	0.00781727

VARIABLE	MINIMUM	MAXIMUM	RANGE	TOTAL
SC	207.000	505.000	298.000	6418.00
CL	7.50000	49.0000	41.5000	687.600
NO3	0.110000	41.8000	41.6900	201.710
KJLDN	1.00000	11.0000	10.0000	56.1000
WT_ELEV	7301.10	7303.20	2.10000	80329.9

file B:OF07B.AB8 version:11

COMMAND: LIST   MISSING VALUE TREATMENT: INCLUDE

CASE	YEAR	SC	CL	NO3	KJLDN	WT_ELEV
1	88.0000	351.000	30.0000	0.120000	4.00000	7300.70
2	80.0000	290.000	28.0000	2.90000	4.10000	--
3	82.0000	340.000	30.0000	2.20000	--	--
4	83.0000	295.000	29.0000	2.20000	--	--
5	84.0000	240.000	29.0000	0.810000	--	7302.00
6	85.0000	280.000	31.0000	5.60000	--	7302.00
7	87.0000	500.000	52.0000	0.140000	--	7301.60
8	89.0000	136.000	11.0000	0.100000	2.20000	7301.90
9	90.0000	293.000	31.0000	6.50000	4.80000	7302.40
10	91.0000	168.000	11.0000	0.470000	2.30000	7302.24
11	92.0000	568.000	41.0000	3.36000	7.90000	7302.14
12	93.0000	264.000	17.9000	0.380000	6.70000	7302.10
13	94.0000	633.000	39.0000	25.0000	7.30000	7302.17
14	95.0000	253.000	28.0000	0.130000	6.90000	7302.32

COMMAND: DESC   MISSING VALUE TREATMENT: VARWISE

*** DESCRIPTIVE STATISTICS ***

THERE ARE 6 VARIABLES AND 14 CASES IN THE DATA SET

VARIABLE	VALID CASES	NUMBER MISSING	% MISSING
SC	14	0	0.0
CL	14	0	0.0
NO3	14	0	0.0
KJLDN	9	5	35.7
WT_ELEV	11	3	21.4

VARIABLE	MEAN	STD.DEV.	VARIANCE	STD ERROR OF MEAN	COEFF OF VARIATION
SC	329.357	143.271	20526.7	38.2909	43.5003
CL	29.1357	10.9402	119.689	2.92390	37.5492
NO3	3.56500	6.51119	42.3956	1.74019	182.642
KJLDN	5.13333	2.15116	4.62750	0.717054	41.9058
WT_ELEV	7301.96	0.471348	0.222169	0.142117	0.00645509

VARIABLE	MINIMUM	MAXIMUM	RANGE	TOTAL
SC	136.000	633.000	497.000	4611.00
CL	11.0000	52.0000	41.0000	407.900
NO3	0.100000	25.0000	24.9000	49.9100
KJLDN	2.20000	7.90000	5.70000	46.2000
WT_ELEV	7300.70	7302.40	1.70000	80321.6

file B0F10.AB8 version:4

COMMAND: LIST

CASE	year	sc	cl	no3	kjldn	wt_elev
1	94	444.000	33.0000	18.5000	0.100000	7302.70
2	95	392.000	19.0000	8.42000	1.70000	7302.95

VARIABLES:

COMMAND: DESC

*** DESCRIPTIVE STATISTICS ***

THERE ARE 6 VARIABLES AND 2 CASES IN THE DATA SET

2 CASES (100.0%) ARE VALID

VARIABLE	MEAN	STD.DEV.	VARIANCE	STD ERROR OF MEAN	COEFF OF VARIATION
sc	418.000	36.7696	1352.00	26.0000	8.79654
cl	26.0000	9.89949	98.0000	7.00000	38.0750
no3	13.4600	7.12764	50.8032	5.04000	52.9542
kjldn	0.900000	1.13137	1.28000	0.800000	125.708
wt_elev	7302.82	0.176777	0.0312500	0.125000	0.00242066

VARIABLE	MINIMUM	MAXIMUM	RANGE	TOTAL
sc	392.000	444.000	52.0000	836.000
cl	19.0000	33.0000	14.0000	52.0000
no3	8.42000	18.5000	10.0800	26.9200
kjldn	0.100000	1.70000	1.60000	1.80000
wt_elev	7302.70	7302.95	0.250000	14605.6

file B:OF11)AB8 version:4

COMMAND: LIST

CASE	year	sc	cl	no3	kjldn	wt_elev
1	94	357.000	43.0000	0.420000	24.2000	7307.84
2	95	398.000	39.0000	0.840000	19.5000	7309.24

COMMAND: DESC

*** DESCRIPTIVE STATISTICS ***

THERE ARE 6 VARIABLES AND 2 CASES IN THE DATA SET

2 CASES (100.0%) ARE VALID

VARIABLE	MEAN	STD.DEV.	VARIANCE	STD ERROR OF MEAN	COEFF OF VARIATION
sc	377.500	28.9914	840.500	20.5000	7.67984
cl	41.0000	2.82843	8.00000	2.00000	6.89860
no3	0.630000	0.296985	0.0882000	0.210000	47.1405
kjldn	21.8500	3.32340	11.0450	2.35000	15.2101
wt_elev	7308.54	0.989949	0.980000	0.700000	0.0135451

VARIABLE	MINIMUM	MAXIMUM	RANGE	TOTAL
sc	357.000	398.000	41.0000	755.000
cl	39.0000	43.0000	4.00000	82.0000
no3	0.420000	0.840000	0.420000	1.26000
kjldn	19.5000	24.2000	4.70000	43.7000
wt_elev	7307.84	7309.24	1.40000	14617.1

Up Stream

file B:OF_UPS.AB8 version:9

COMMAND: LIST   MISSING VALUE TREATMENT: INCLUDE

VARIABLES:

CASE	YEAR	SC	CL	NO3	KJLDN	WT_ELEV
1	0.00000	118.000	10.0000	0.100000	--	--
2	75.0000	125.000	8.30000	0.0100000	0.0100000	--
3	76.0000	140.000	8.00000	0.0850000	0.450000	--
4	78.0000	140.000	20.0000	0.0100000	0.790000	--
5	79.0000	130.000	9.20000	0.0100000	4.80000	--
6	80.0000	120.000	10.0000	0.0100000	0.440000	--
7	82.0000	120.000	8.40000	0.0500000	--	--
8	83.0000	125.000	7.80000	0.0500000	--	--
9	84.0000	120.000	8.50000	0.0500000	--	--
10	85.0000	125.000	8.50000	0.0500000	--	--
11	87.0000	110.000	0.00000	0.0700000	--	--
12	89.0000	133.000	9.00000	30.0000	0.440000	--
13	90.0000	123.000	7.80000	0.0100000	0.200000	--
14	91.0000	118.000	10.0000	0.0500000	0.100000	--
15	92.0000	144.000	11.0000	0.0500000	0.100000	--
16	93.0000	132.000	7.70000	0.100000	0.100000	--
17	94.0000	138.000	9.00000	0.0100000	0.100000	--
18	95.0000	104.000	9.00000	0.0500000	0.100000	--

COMMAND: DESC   MISSING VALUE TREATMENT: VARWISE

*** DESCRIPTIVE STATISTICS ***

THERE ARE 6 VARIABLES AND 18 CASES IN THE DATA SET

VARIABLE	VALID CASES	NUMBER MISSING	% MISSING
SC	18	0	0.0
CL	18	0	0.0
NO3	18	0	0.0
KJLDN	12	6	33.3
WT_ELEV	0	18	100.0

VARIABLE	MEAN	STD.DEV.	VARIANCE	STD ERROR OF MEAN	COEFF OF VARIATION
SC	125.833	10.7060	114.618	2.52342	8.50805
CL	9.01111	3.56418	12.7034	0.840086	39.5532
NO3	1.70917	7.06053	49.8510	1.66418	413.098
KJLDN	0.635833	1.33118	1.77204	0.384279	209.360
WT_ELEV	0.00000	0.00000	0.00000	0.00000	0.00000

VARIABLE	MINIMUM	MAXIMUM	RANGE	TOTAL
SC	104.000	144.000	40.0000	2265.00
CL	0.00000	20.0000	20.0000	162.200
NO3	0.0100000	30.0000	29.9900	30.7650
KJLDN	0.0100000	4.80000	4.79000	7.63000
WT_ELEV	--	--	0.00000	0.00000

Down Stream

file B:OF_DNS.AB8 version:8

COMMAND: LIST   MISSING VALUE TREATMENT: INCLUDE

VARIABLES:

CASE	YEAR	SC	CL	NO3	KJLDN	WT_ELEV
1	88.0000	178.000	22.0000	0.100000	--	--
2	75.0000	170.000	14.0000	0.0100000	0.120000	--
3	76.0000	190.000	16.0000	0.0100000	0.450000	--
4	78.0000	140.000	20.0000	0.0100000	0.790000	--
5	79.0000	180.000	21.0000	0.0900000	0.160000	--
6	80.0000	178.000	19.0000	0.0100000	0.720000	--
7	82.0000	175.000	14.5000	0.0500000	--	--
8	83.0000	170.000	18.0000	0.0500000	--	--
9	84.0000	170.000	16.0000	0.0500000	--	--
10	85.0000	170.000	17.0000	0.0500000	--	--
11	87.0000	175.000	18.0000	0.110000	--	--
12	89.0000	183.000	17.0000	0.0100000	0.570000	--
13	90.0000	179.000	17.0000	0.0400000	0.400000	--
14	91.0000	188.000	21.0000	0.0500000	0.100000	--
15	92.0000	178.000	19.0000	0.0500000	0.300000	--
16	93.0000	197.000	20.4000	0.110000	0.100000	--
17	94.0000	196.000	20.0000	0.0500000	0.100000	--
18	95.0000	155.000	22.0000	0.0500000	0.100000	--

COMMAND: DESC   MISSING VALUE TREATMENT: VARWISE

*** DESCRIPTIVE STATISTICS ***

THERE ARE 6 VARIABLES AND 18 CASES IN THE DATA SET

VARIABLE	VALID CASES	NUMBER MISSING	% MISSING
SC	18	0	0.0
CL	18	0	0.0
NO3	18	0	0.0
KJLDN	12	6	33.3
WT_ELEV	0	18	100.0

VARIABLE	MEAN	STD.DEV.	VARIANCE	STD ERROR OF MEAN	COEFF OF VARIATION
SC	176.222	13.6104	185.242	3.20799	7.72341
CL	18.4389	2.44399	5.97310	0.576055	13.2546
NO3	0.0500000	0.0337813	0.00114118	0.00796233	67.5626
KJLDN	0.325833	0.256885	0.0659902	0.0741565	78.8395
WT_ELEV	0.00000	0.00000	0.00000	0.00000	0.00000

VARIABLE	MINIMUM	MAXIMUM	RANGE	TOTAL
SC	140.000	197.000	57.0000	3172.00
CL	14.0000	22.0000	8.00000	331.900
NO3	0.0100000	0.110000	0.100000	0.900000
KJLDN	0.100000	0.790000	0.690000	3.91000
WT_ELEV	--	--	0.00000	0.00000

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FINAL REPORT
ANALYSIS OF WATER SAMPLES COLLECTED NEAR
FOUR SEWAGE TREATMENT FACILITIES
YELLOWSTONE NATIONAL PARK, WY
FEBRUARY 1997

ARMAND MORRIS AND ASSOCIATES, INC.
PO BOX 40170
CASPER, WYOMING 82604

7.1 SUMMARY OF MONITOR WELL MEASUREMENTS
OLD FAITHFUL
AUGUST 10-11, 1996

Sample Point	Surface Elev (ft)	Stickup (ft)	Water Depth (ft)	Water Elev (ft)	Cased Depth (ft)	Measured Depth (ft)	Fill (ft)
OF-1	7340.60	0.93	6.44	7335.09	29.0	25.0	4.9
OF-2	7337.60	0.82	28.76	7309.66	48.0	46.2	2.6
OF-3	7336.60	1.16	28.70	7309.06	65.0	61.2	5.0
OF-4	7334.90	1.04	29.22	7306.72	49.0	43.3	6.7
OF-5	7332.30	0.97	30.59	7302.68	49.0	33.7	16.3
OF-7B	7312.60	0.88	11.35	7302.13	29.0	27.5	2.4
OF-10	7330.02	1.45	28.87	7302.60	33.0	34.2	0.2
OF-11	7336.38	1.55	28.85	7309.08	38.0	39.4	0.2

Explanation -

Stickup - The measurement of casing above the ground surface. This measurement was made prior to measuring the depth of the well.

Water Depth - measured from the top of the casing

Surface Elevation and Cased Depth were obtainted from Table 2, (page 12) of the Work Statement

Fill = Cased Depth - Measured Depth + Stickup

7.2 SUMMARY OF GROUND WATER ANALYSIS
OLD FAITHFUL
AUGUST 10-11, 1996

Sample Point	Water Elev (ft)	Conduct (m-mu/C)	Temp (f)		NO2 + NO3 as N (mg/L)	Cl (mg/L)	TKN (mg/L)
OF-1	7335.09	110	58	<	0.10	4.2	1.10
OF-2	7309.66	440	64	<	0.10	37.4	21.90
OF-3	7309.06	345	60		2.34	35.1	13.40
OF-4	7306.72	390	68		5.20	31.6	6.20
OF-5	7302.68	235	51		9.95	34.3	2.50
OF-7B	7302.13	190	52		0.10	11.3	4.50
OF-10	7302.60	240	51		4.16	26.2	2.50
OF-11	7309.08	410	60		0.84	36.8	16.50
Iron Spr. Above Lagoon (OF-1)		110	59	<	0.10	6.7	0.20
Iron Spr. Below Lagoon (OF-2)		123	69	<	0.10	13.8	0.30

.2 SUMMARY OF GROUND WATER ANALYSIS
LD FAITHFUL
UGUST 25 - 27, 1997

Sample Point	Water Elev (ft)	Conduct umhos/cm	Temp (f)		N02 + N03 as N (mg/L)	Cl (mg/L)		TKN (mg/L)
F-1	7334.80	147	57	<	0.10	3.4		0.80
F-2	7309.70	448	63		0.23	34.9		18.70
F-3	7309.59	302	61		3.73	34.1		5.70
F-4	7307.03	330	63		2.53	33.8		8.10
F-5	7303.28	348	56		10.90	32.4		1.20
F-7B	7302.74	336	48	<	0.10	25.6		4.80
F-10	7303.11	272	53		6.35	29.1		1.70
F-11	7309.20	398	61		0.94	33.6		16.40
ron Spr. Above Lagoon (OF-1)		142	52	<	0.10	5.5	<	0.50
ron Spr. Below Lagoon (OF-2)		181	66	<	0.10	11.0	<	0.50

MMARY OF MONITOR WELL MEASUREMENTS
AITHFUL
ST 25 -27, 1997

le nt	Surface Elev (ft)	Stickup (ft)	Water Depth (ft)	Water Elev (ft)	Cased Depth (ft)	Measured Depth (ft)	Fill (ft)
	7340.60	0.93	6.73	7334.80	29.0	24.7	5.2
	7337.60	0.82	28.72	7309.70	48.0	46.5	2.3
	7336.60	1.16	28.17	7309.59	65.0	61.7	4.5
	7334.90	1.04	28.91	7307.03	49.0	43.5	6.5
	7332.30	0.97	29.99	7303.28	49.0	33.5	16.5
	7312.60	0.88	10.74	7302.74	29.0	27.6	2.2
	7330.02	1.45	28.36	7303.11	33.0	34.2	0.2
	7336.38	1.55	28.73	7309.20	38.0	39.6	0.0

nation -

up - The measurement of casing above the ground surface. This
urement was made prior to measuring the depth of the well.

r Depth - measured from the top of the casing

ce Elevation and Cased Depth were obtainted from Table 2
Work Statement. Cased depth is measured from ground level.